

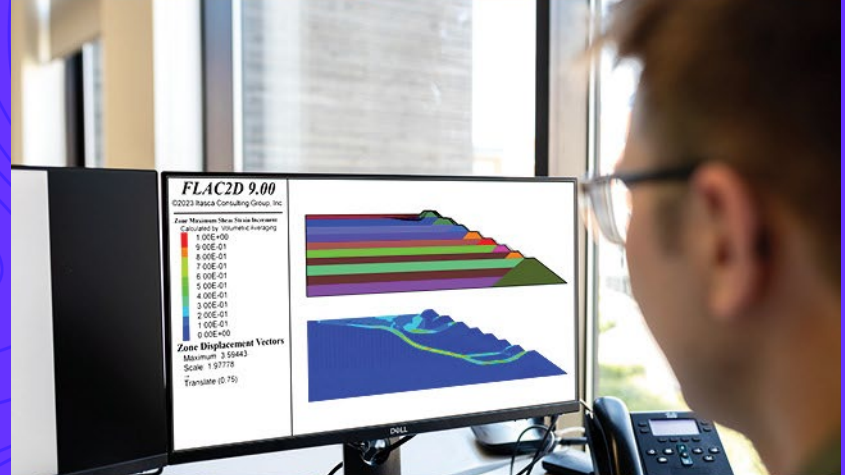
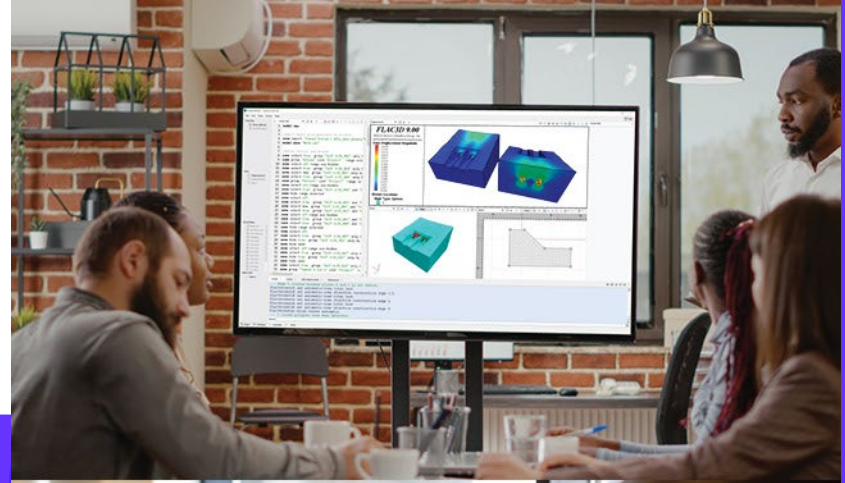


ITASCA
Software

3DEC 9

February 5, 2024

itascacg.com



SOFTWARE

CONSULTING

RESEARCH

Presenters

- Jim Hazzard, 3DEC Product Manager



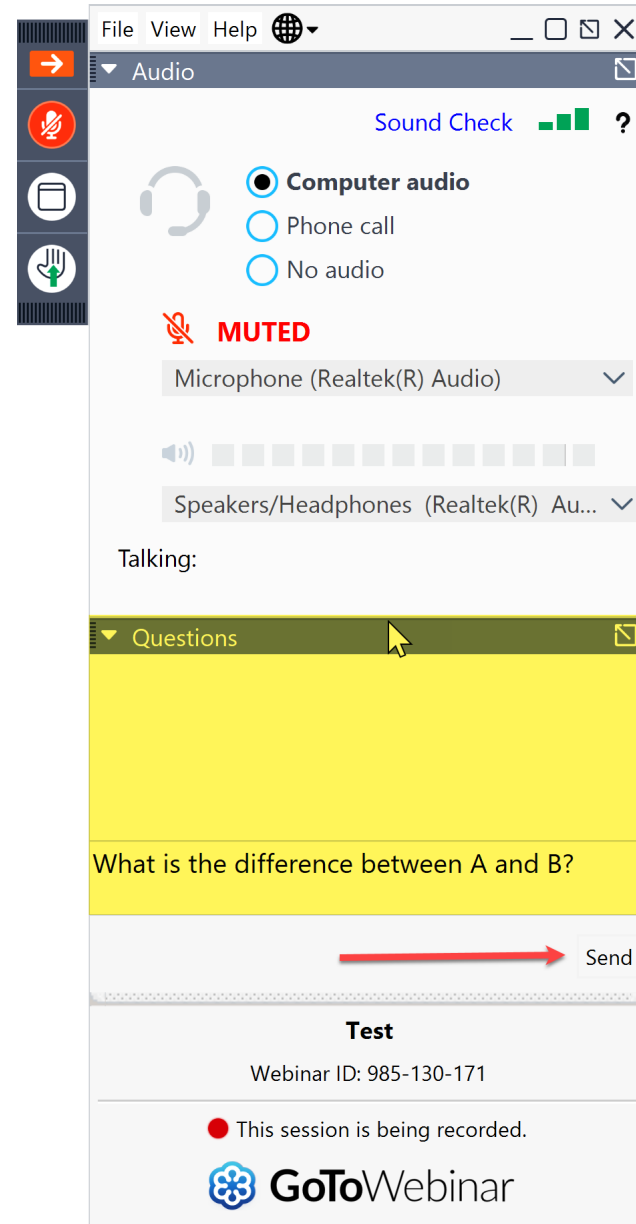
- David DeGagné, Technical Marketing



Questions & Answers

To type your questions, please use **Questions** dialog in the **GoToWebinar** window.

Questions will be answered at the end of the webinar.



POLL

1 of 3

3DEC 9

- What is 3DEC?
- Applications
- New Features in Version 9
 - UI
 - Performance
 - Structural Elements
 - Constitutive Models
 - Other New Features

What is 3DEC?

- An assembly of rigid or deformable **blocks** interacting at **contacts**

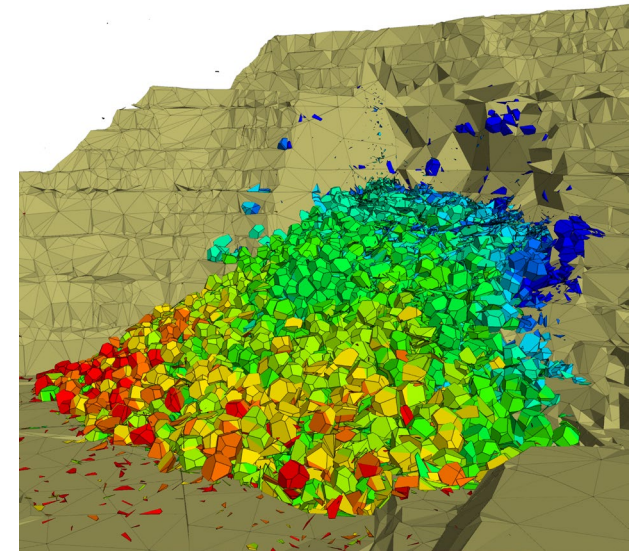
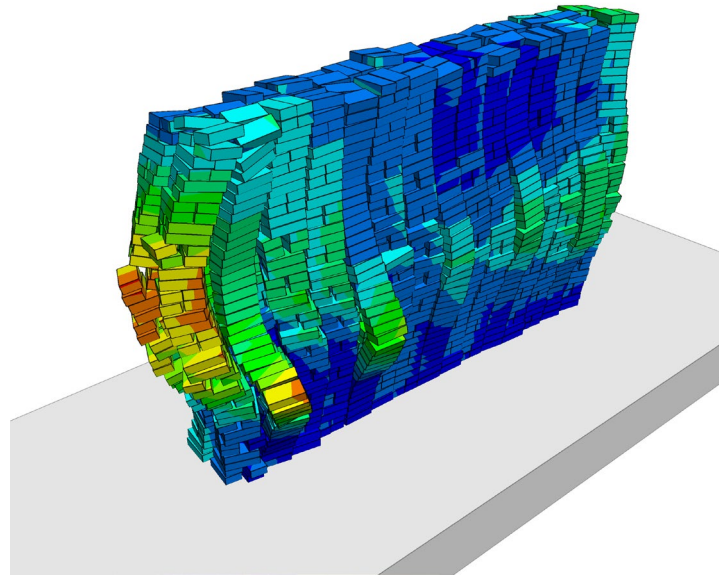
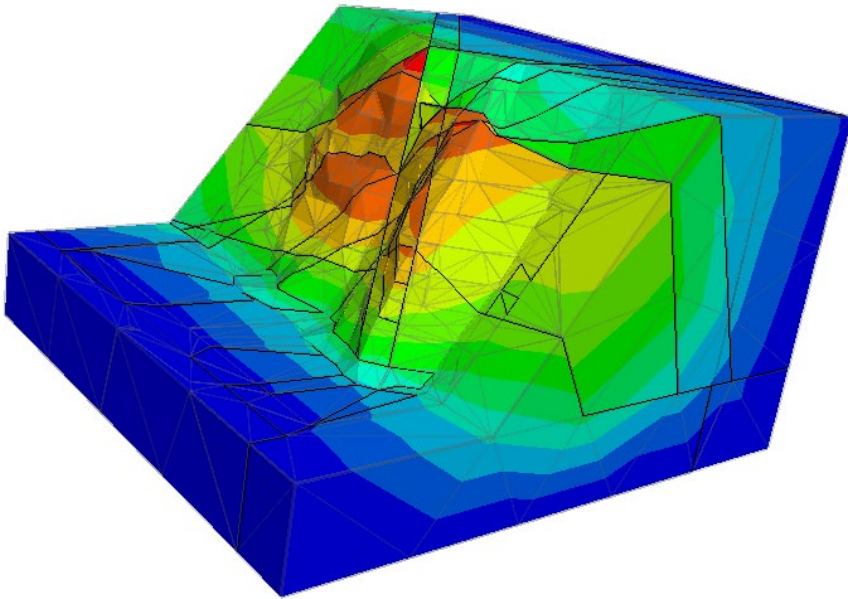
Fractured continuum



Blocky material

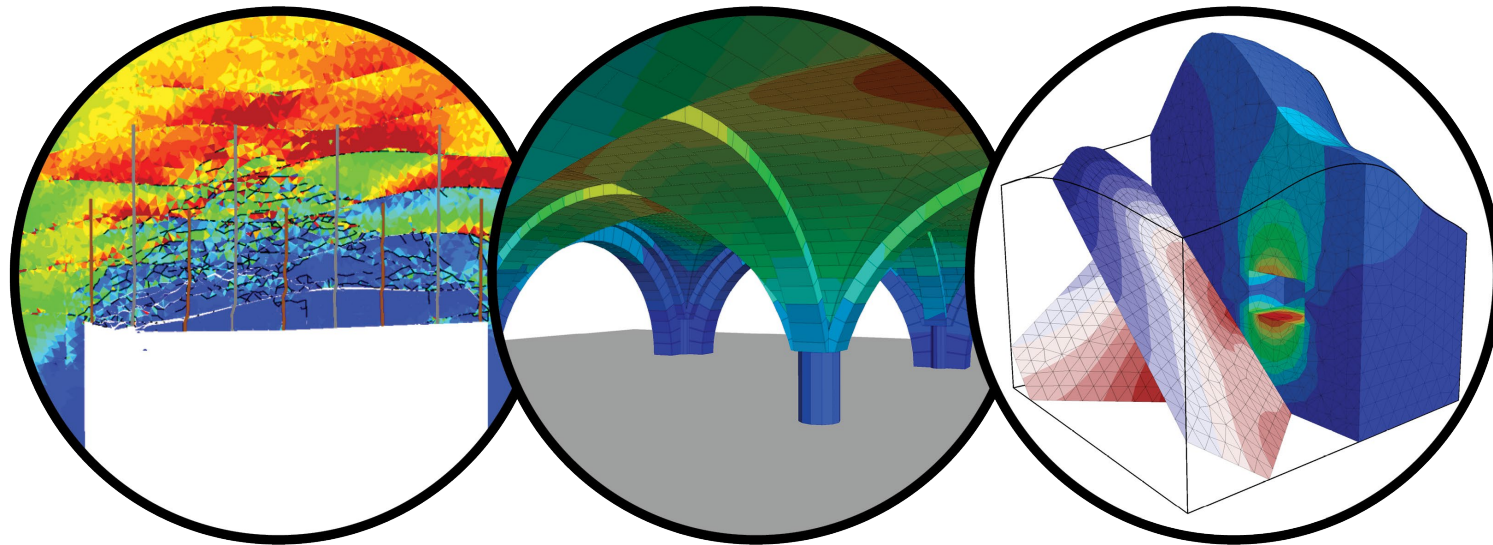


Discontinuum



What is 3DEC

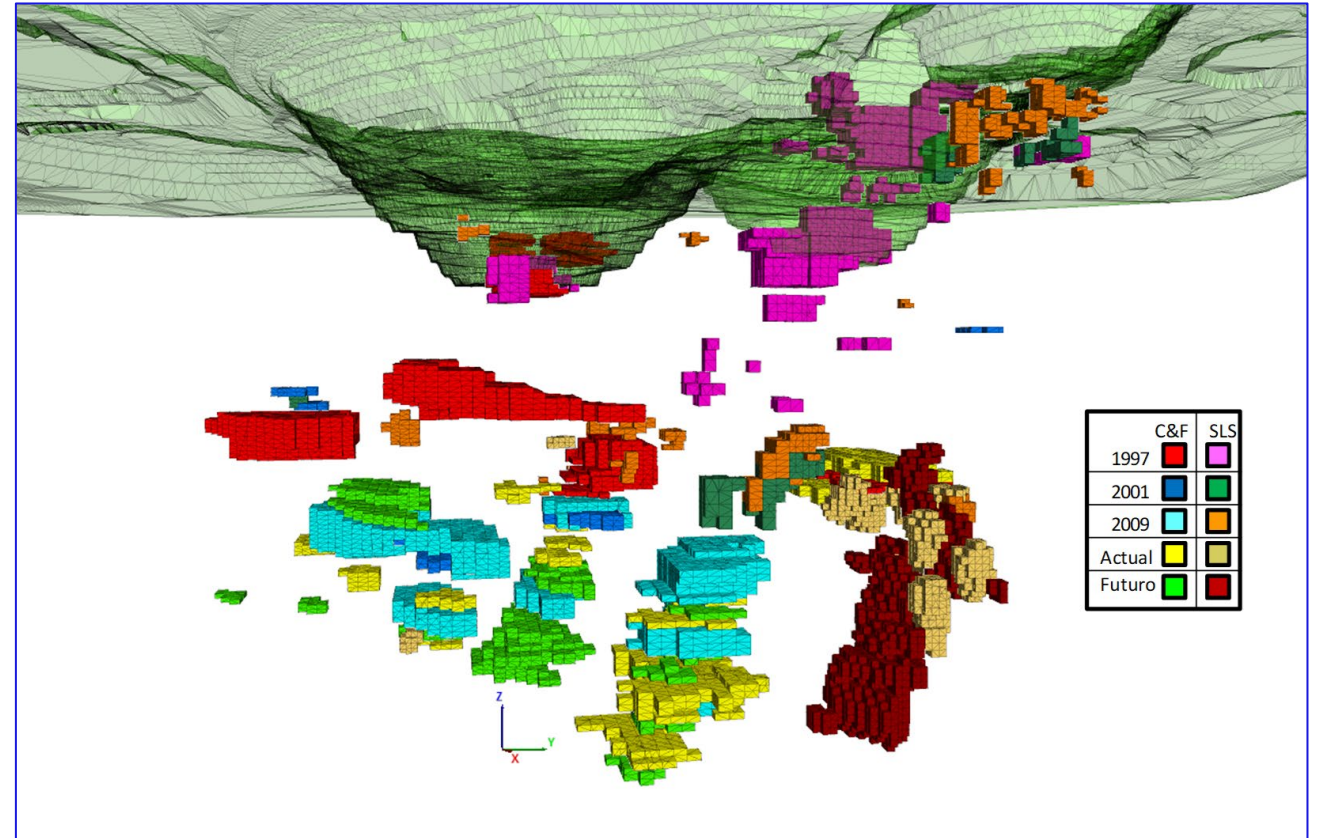
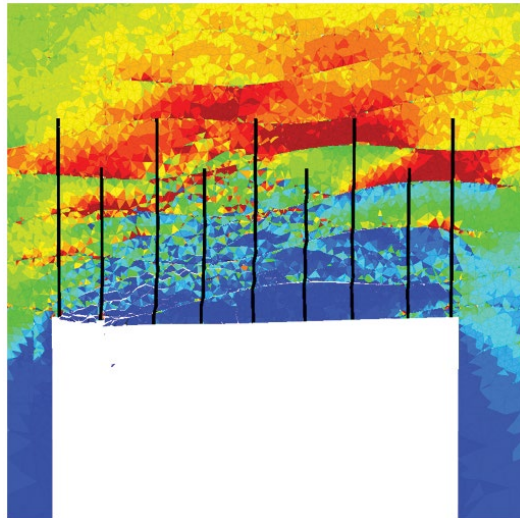
- Hybrid numerical modeling:
 - Discontinuities simulated with **Distinct Element Method** allowing shear movement, block separation and block rotation.
 - Continuum uses the **Finite Volume** formulation: unstructured mesh for modeling deformation and failure of blocks
 - **Explicit** solution scheme: time-marching solution best for dynamic solutions, large strain problems and highly non-linear material behavior



Applications

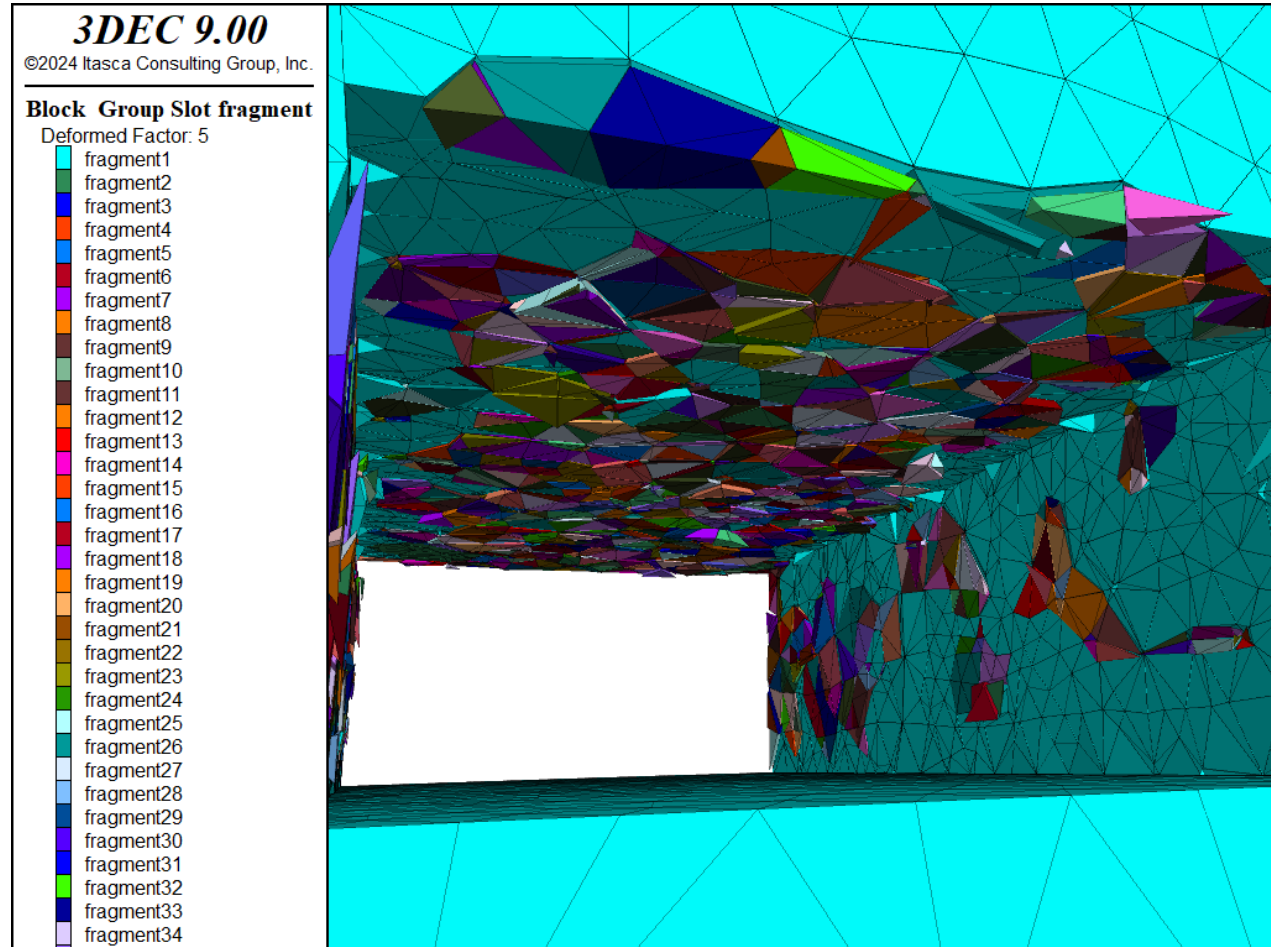
Applications

- **Underground Mining**



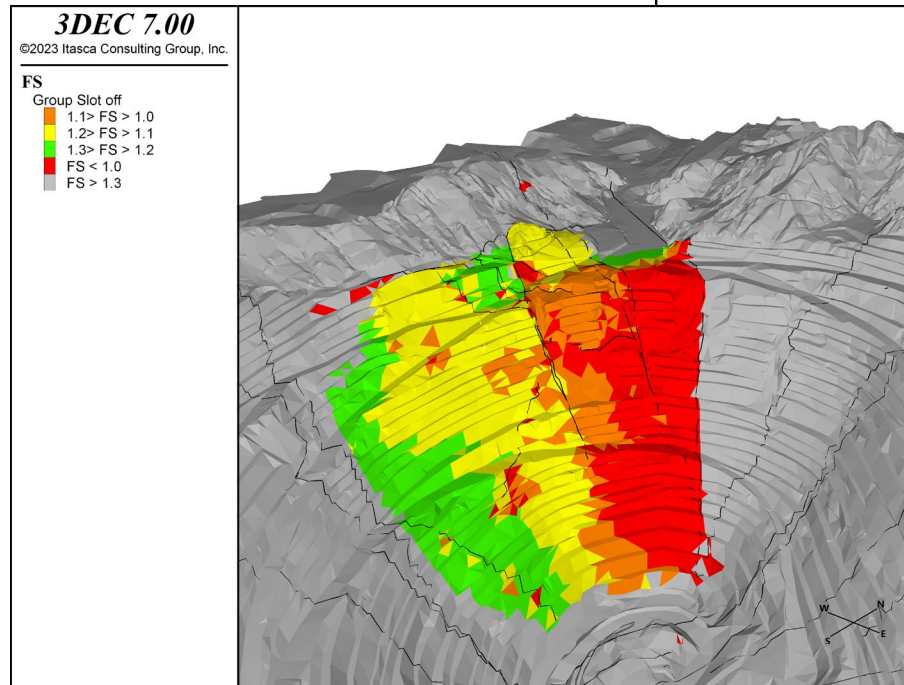
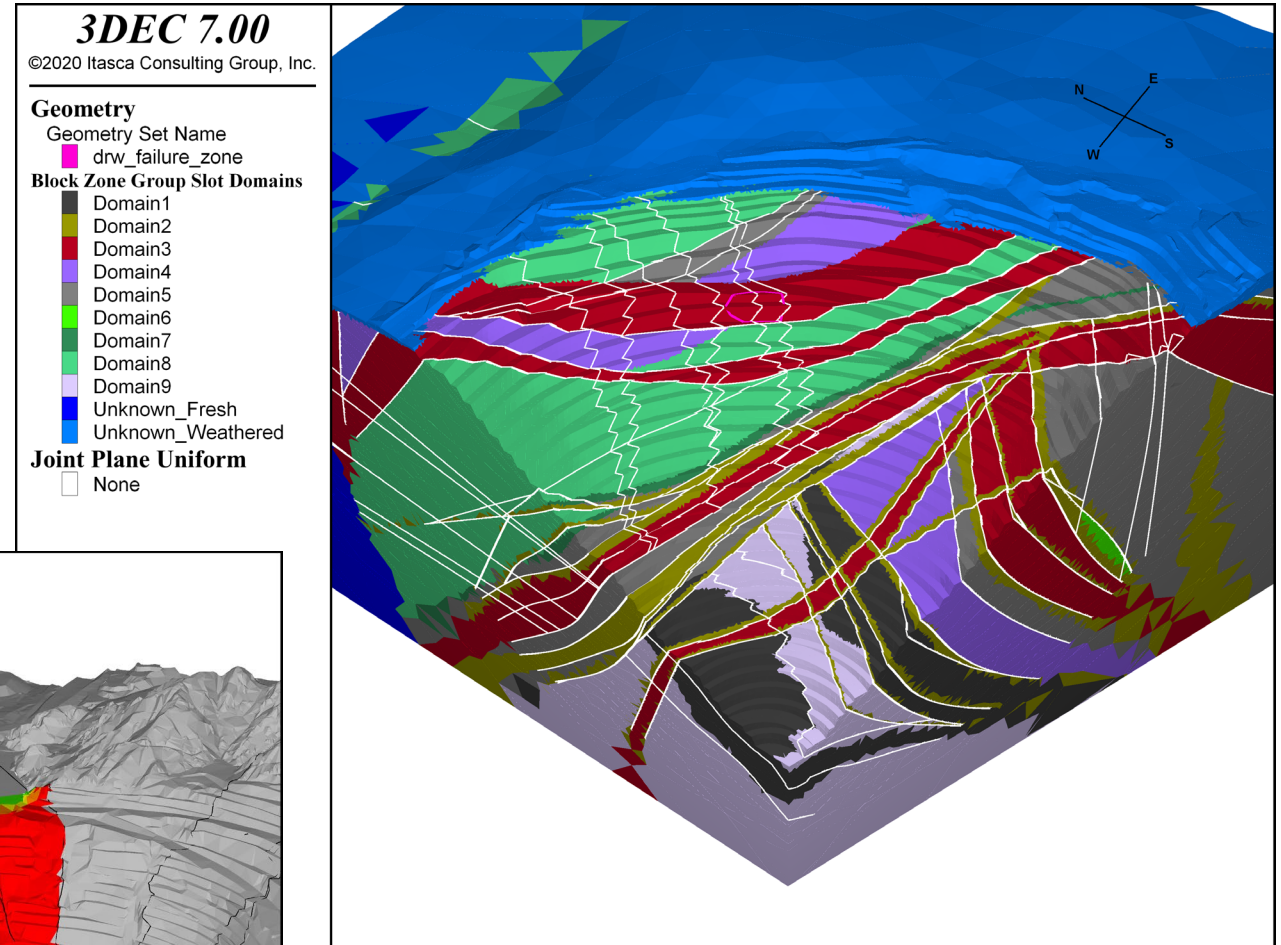
Applications

- Underground Mining
- **Caving / Fragmentation**



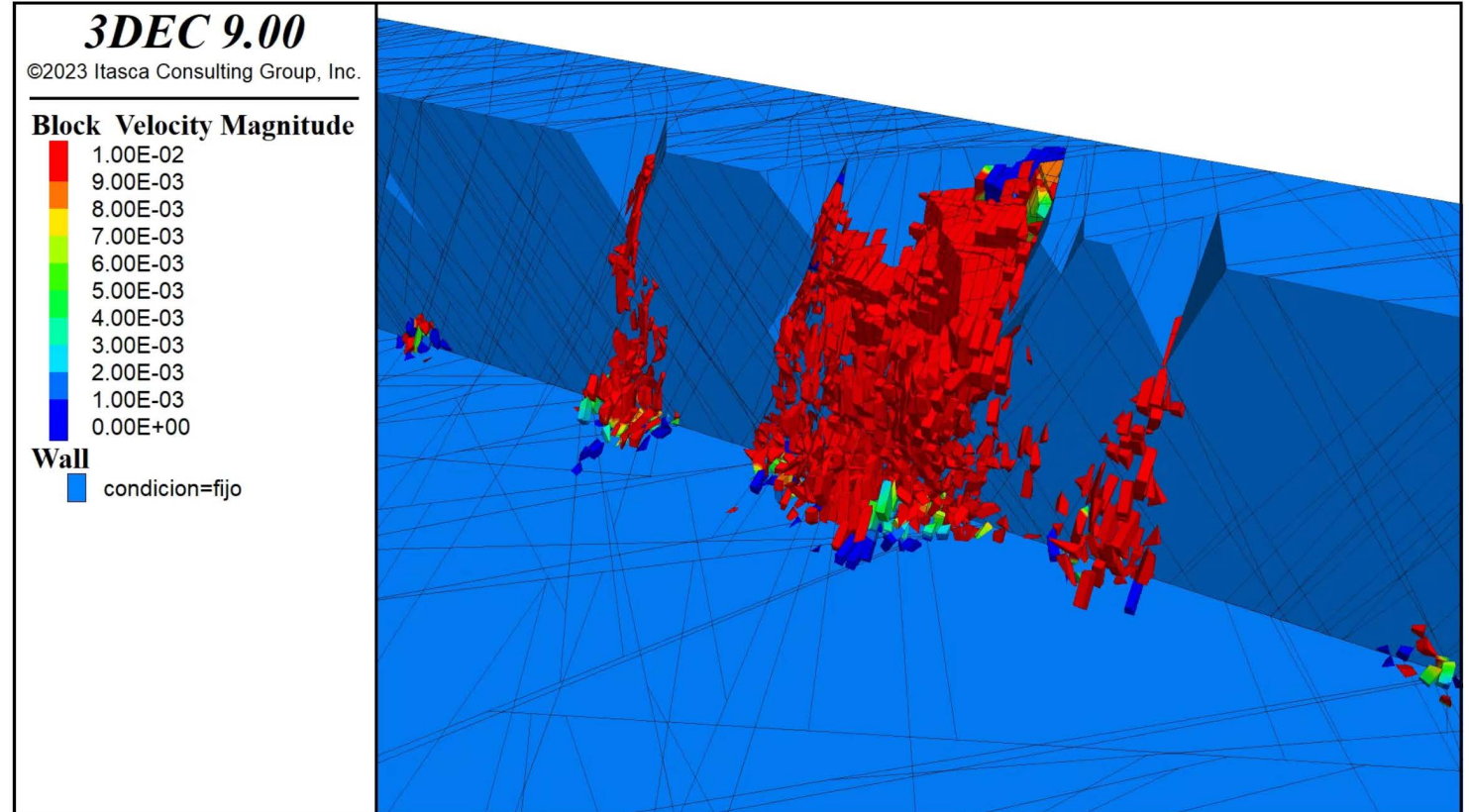
Applications

- Underground Mining
- Caving / Fragmentation
- **Open Pit Mining**
 - Mine Scale



Applications

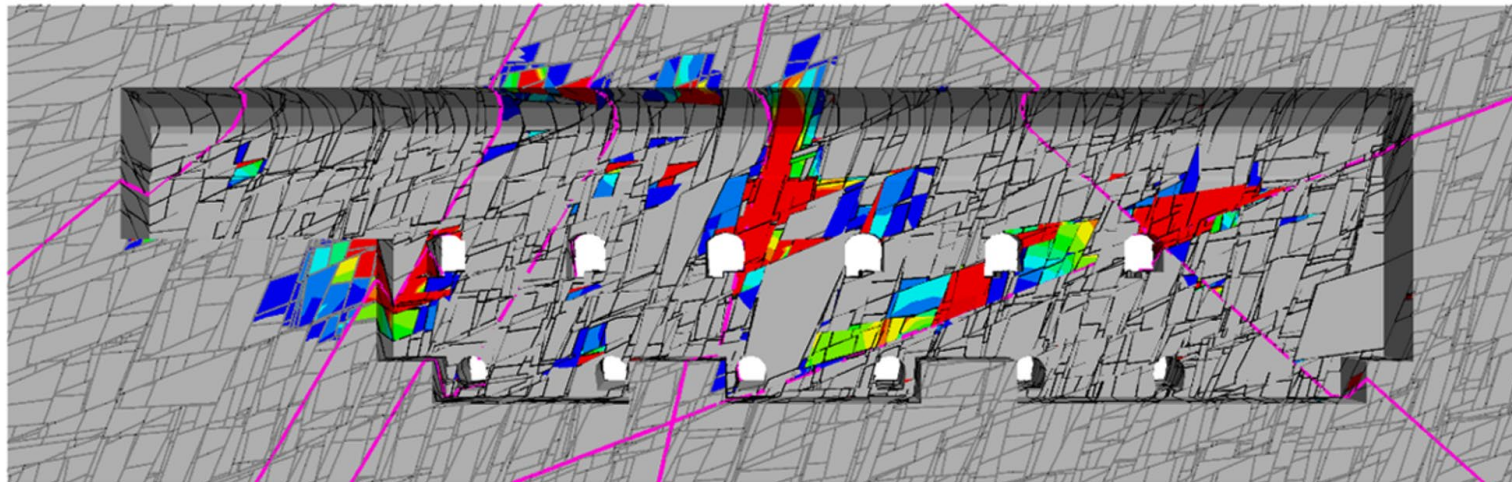
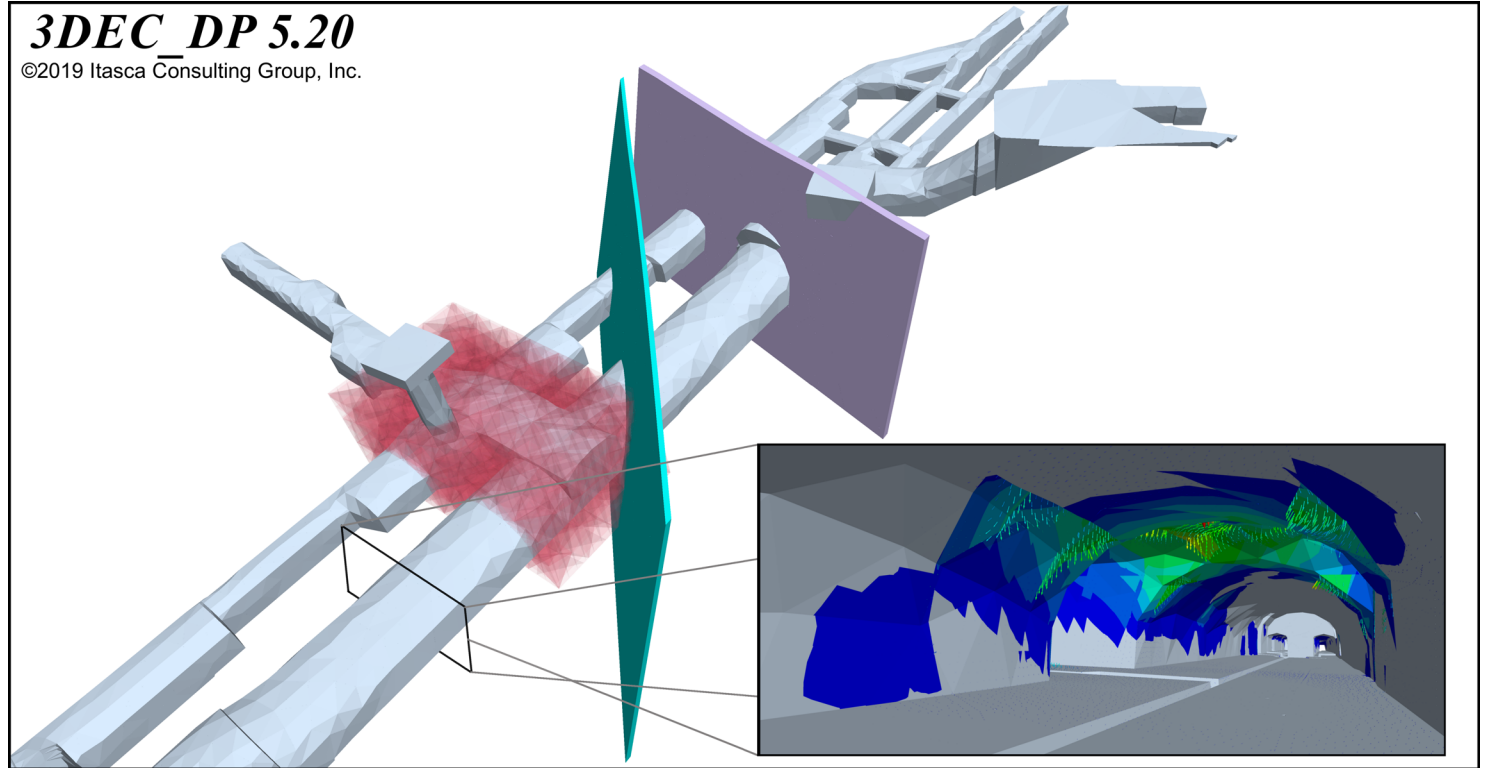
- Underground Mining
- Spalling and Support
- Caving / Fragmentation
- **Open Pit Mining**
 - Mine Scale
 - Bench Scale



Applications

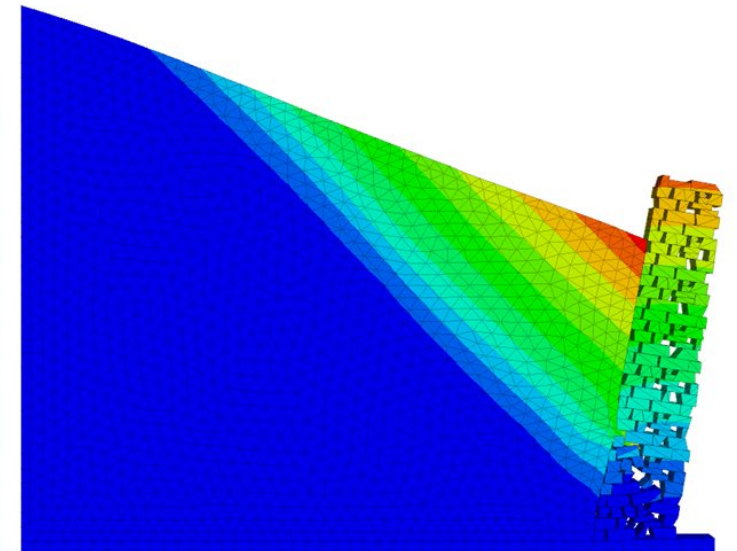
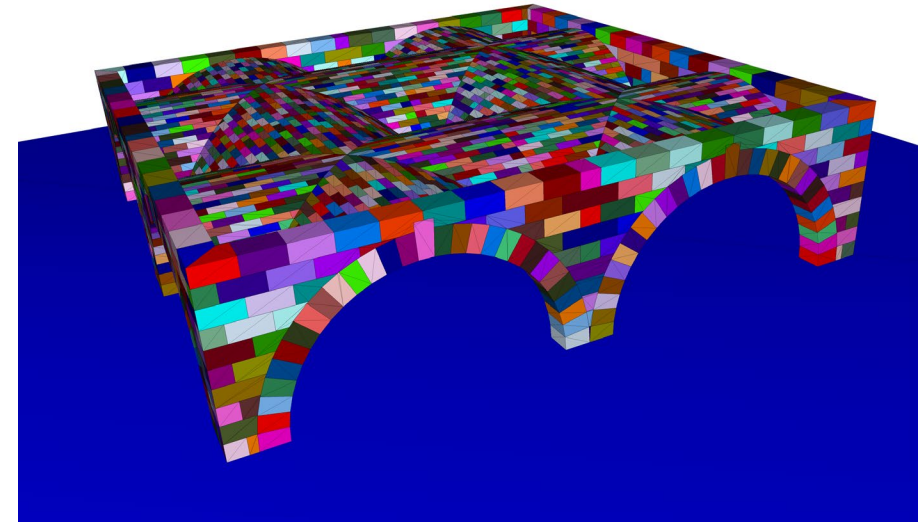
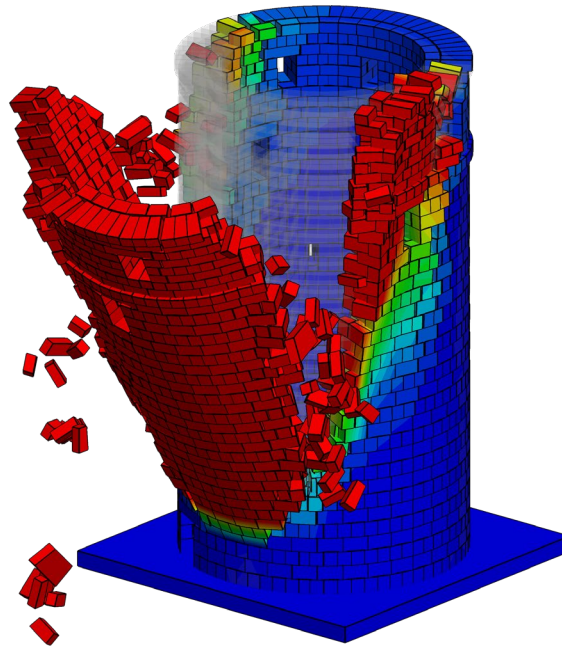
- Underground Mining
- Spalling and Support
- Caving / Fragmentation
- Open Pit Mining
- **Civil Tunnels**

3DEC DP 5.20
©2019 Itasca Consulting Group, Inc.



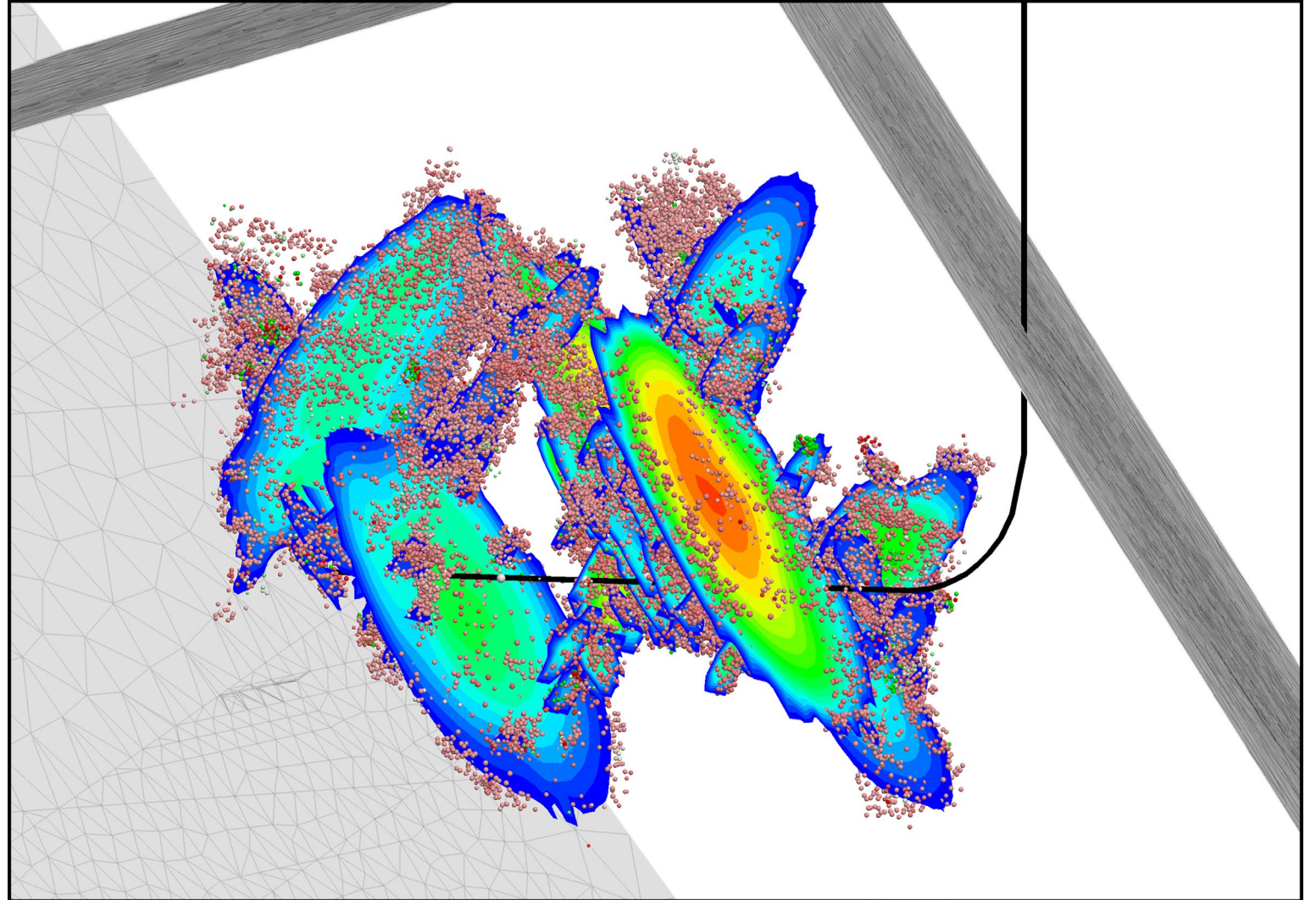
Applications

- Underground Mining
- Spalling and Support
- Caving / Fragmentation
- Open Pit Mining
- Civil Tunnels
- **Masonry Structures**



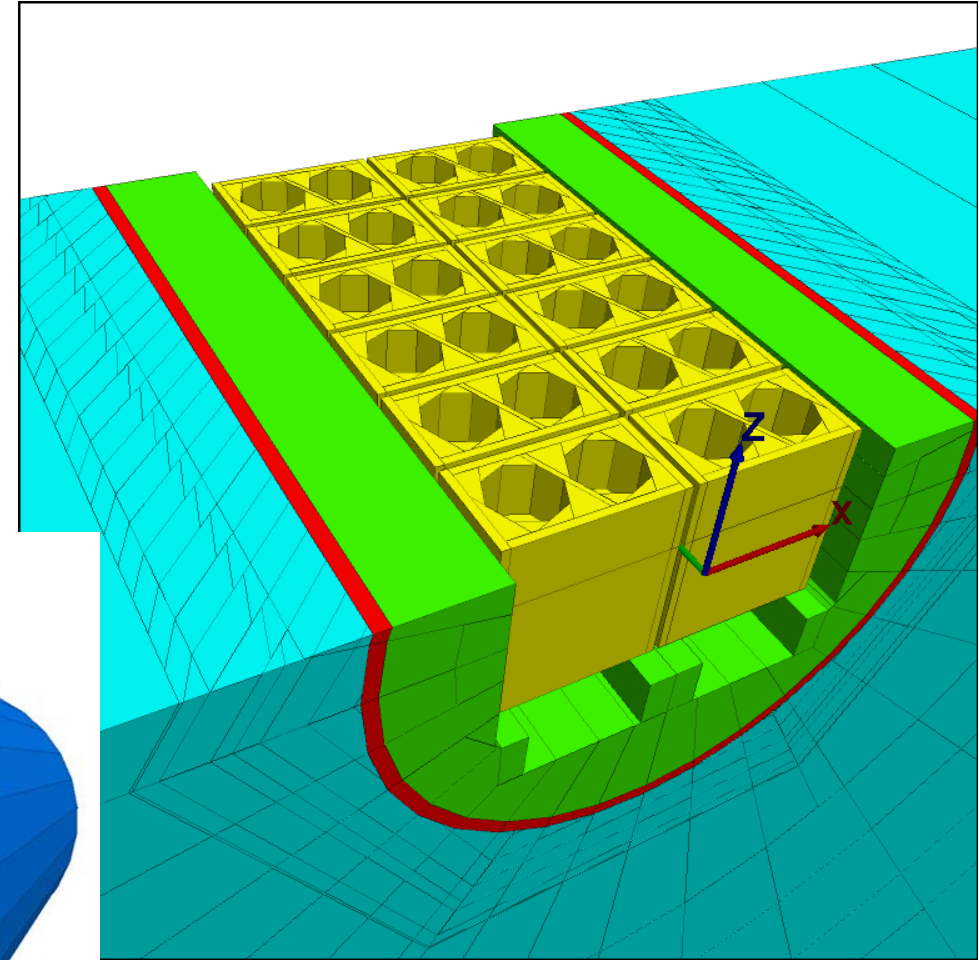
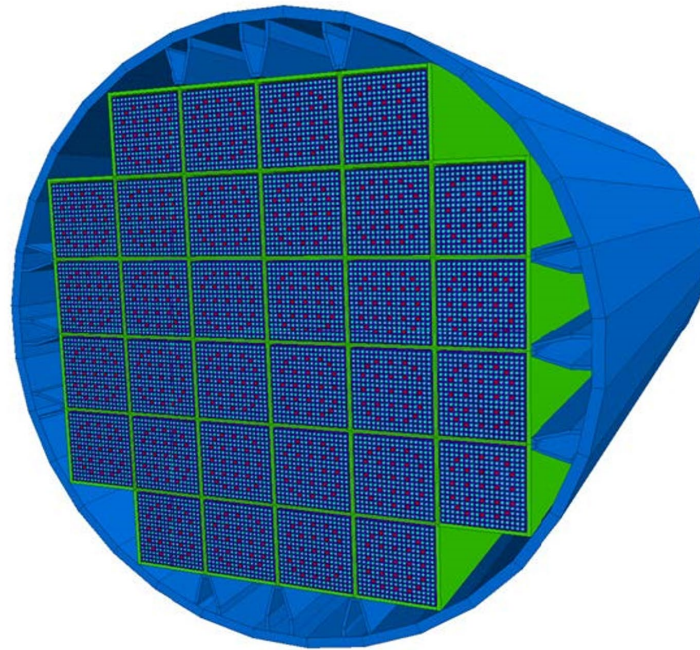
Applications

- Underground Mining
- Spalling and Support
- Caving / Fragmentation
- Open Pit Mining
- Civil Tunnels
- Masonry Structures
- **Hydraulic Fracture**



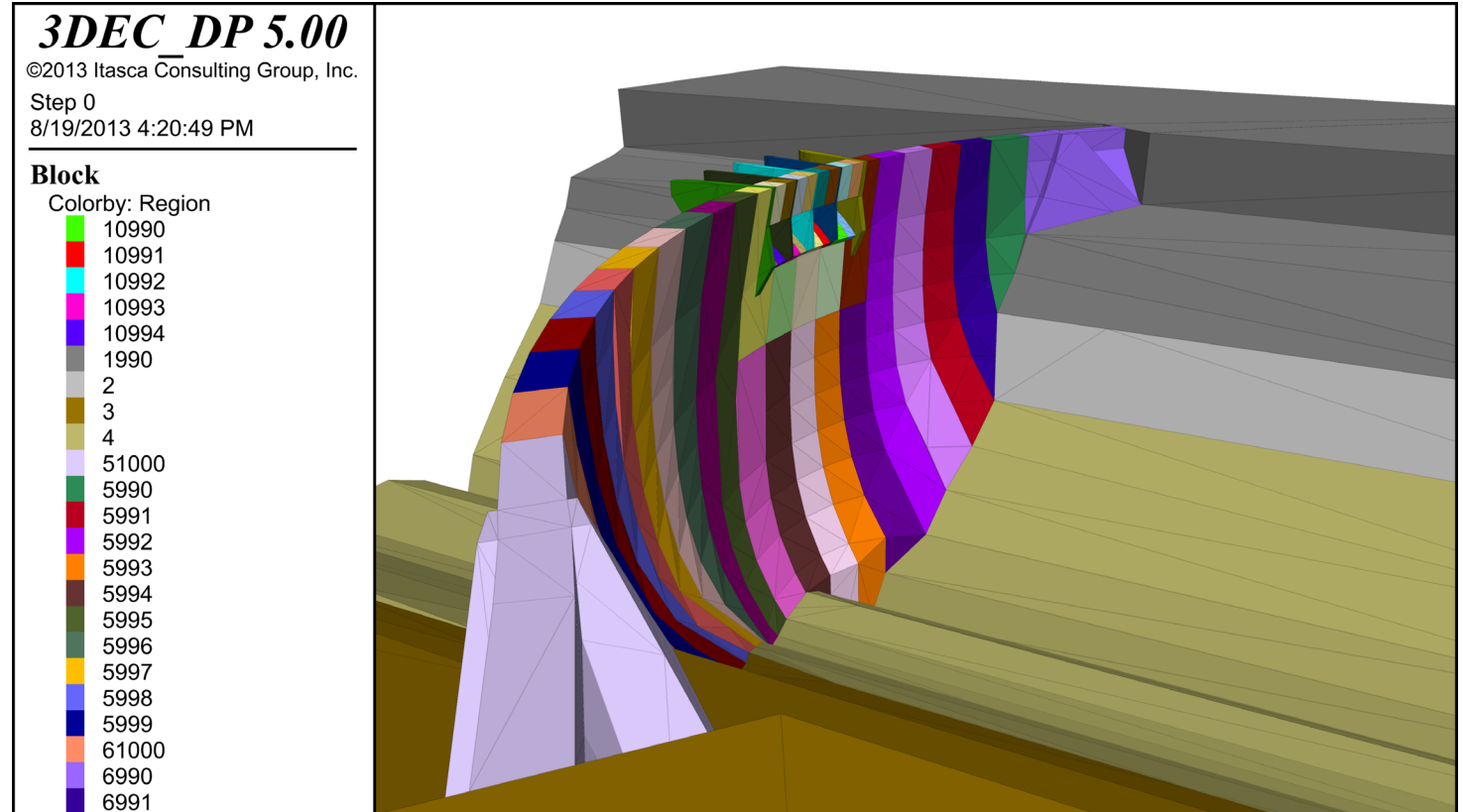
Applications

- Underground Mining
- Spalling and Support
- Caving / Fragmentation
- Open Pit Mining
- Civil Tunnels
- Masonry Structures
- Hydraulic Fracture
- **Nuclear Waste Disposal**



Applications

- Underground Mining
- Spalling and Support
- Caving / Fragmentation
- Open Pit Mining
- Civil Tunnels
- Masonry Structures
- Hydraulic Fracture
- Nuclear Waste Disposal
- **Dams**



Applications

- Underground Mining
- Spalling and Support
- Caving / Fragmentation
- Open Pit Mining
- Civil Tunnels
- Masonry Structures
- Hydraulic Fracture
- Nuclear Waste Disposal
- Dams
- **Other**




3DEC_DP 5.20

©2018 Itasca Consulting Group, Inc.

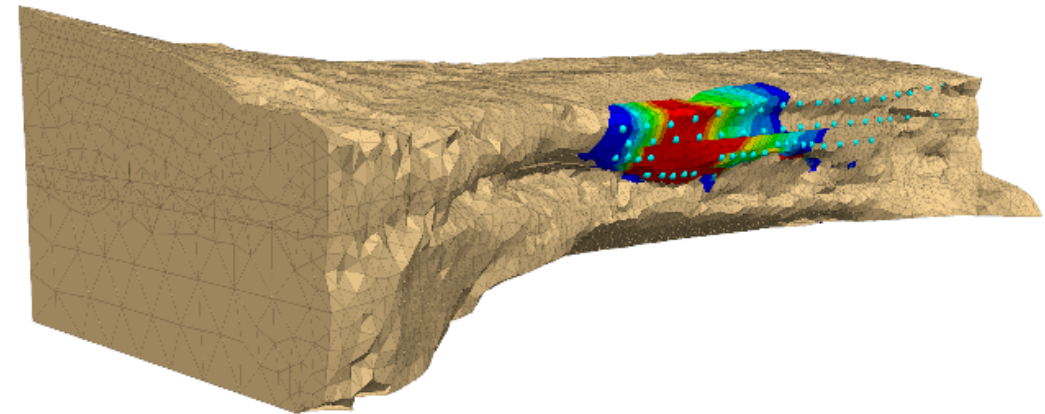
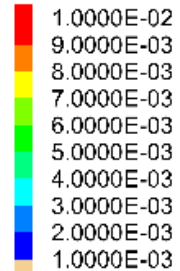
Step 767638

7/30/2018 1:13:14 PM

Geometry

 cablespheres

Contour Of Displacement



POLL

2 of 3

New Features in Version 9

Splittable working area

The screenshot displays the 3DEC software interface with the following components:

- Data Files Panel:** Lists files such as master.dat, tunnel_geom.dat, tunnel_ini.dat, tunnel_exc.dat, check.fis, tunnel_cables.dat, and tunnel_liner.dat.
- Plots Panel:** Includes options for Disp His, Disp His Roof, Blocks, Cables (highlighted), and Liner.
- Code Editor:** Contains a script with commands like `model new`, `model rand`, `model larg`, `block create brick`, `fish define tunz`, and `local tab = table.create('tunnel')`.
- 3D Model:** A 3D visualization of a tunnel structure with a semi-circular roof, overlaid with a mesh. A color scale for 'Cable Axial Force' is shown, ranging from 3.44E-04 to 7.58E-02.
- Console:** Shows the execution of `3dec>project new` and `3dec>model restore "tunnel_cables.sav"`, displaying model information and cycle counts.
- Buttons:** Project, Workspace, and Commands buttons are located at the bottom left.

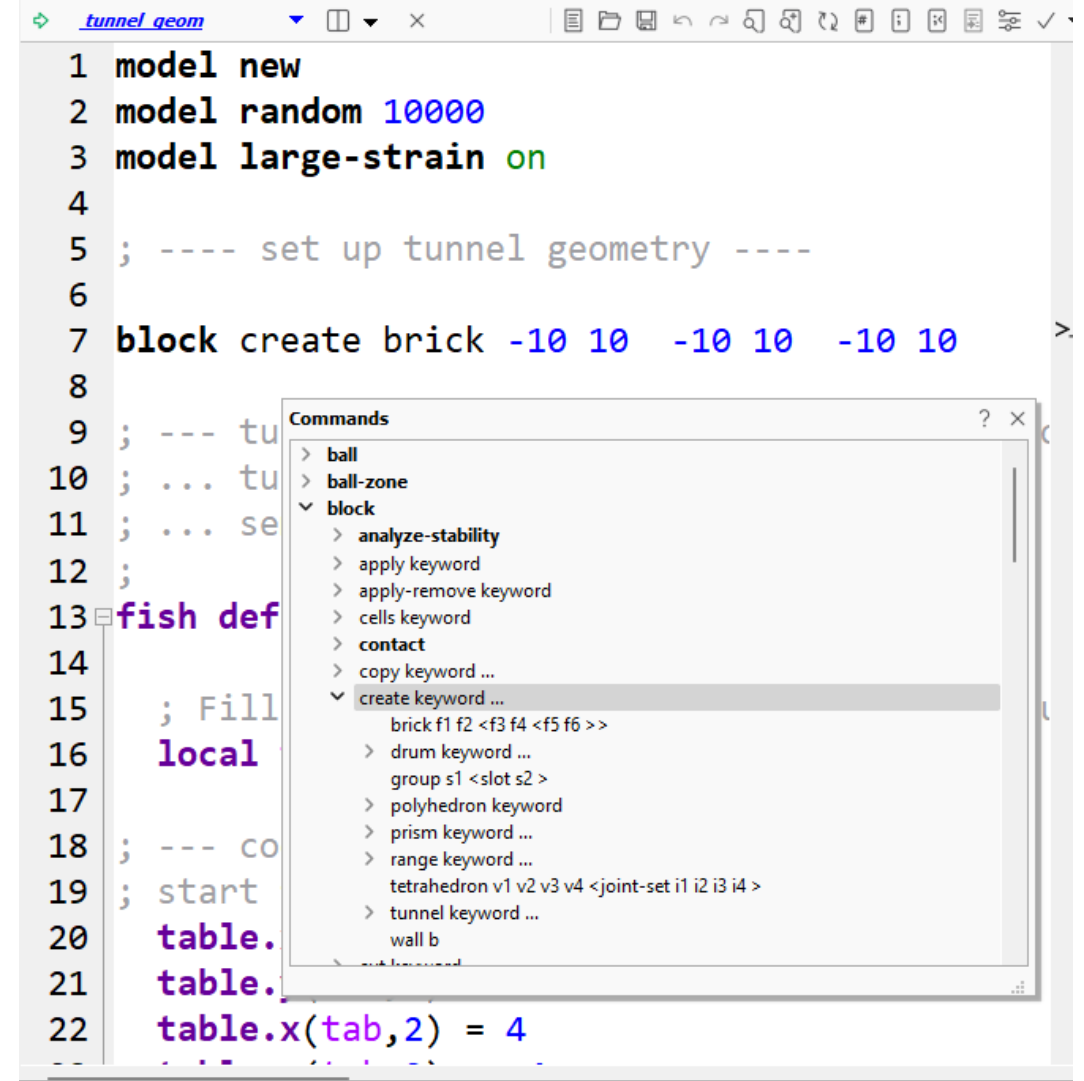
Plots listed in Project Panel

Turn on or off different panels

New colors and icons

UI – Inline Help

- CTRL-Space brings up inline help
- All commands now available in persistent window



The screenshot shows a code editor window titled 'tunnel_geom'. The code is as follows:

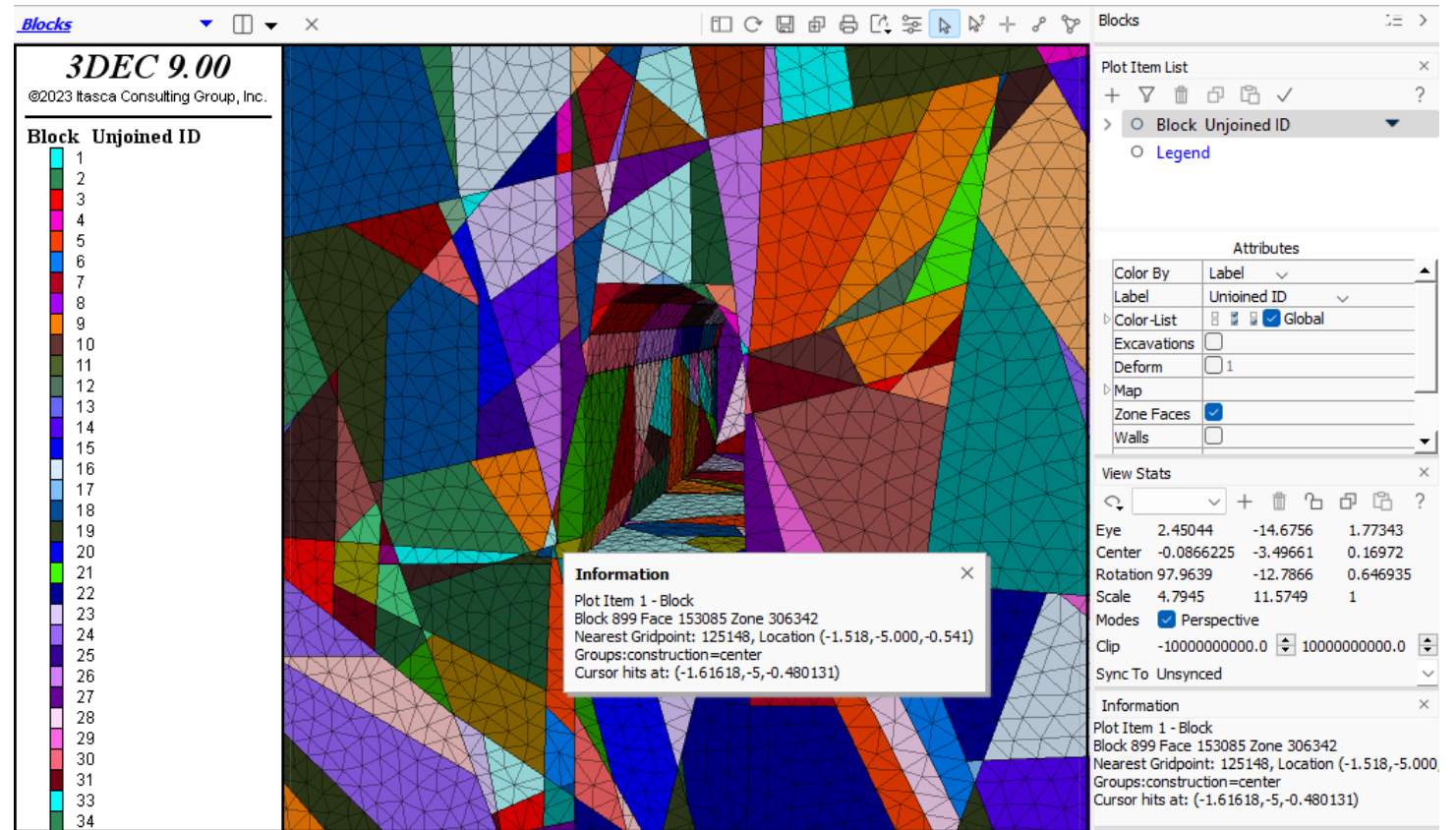
```
1 model new
2 model random 10000
3 model large-strain on
4
5 ; ---- set up tunnel geometry ----
6
7 block create brick -10 10 -10 10 -10 10
8
9 ; --- tu
10 ; ... tu
11 ; ... se
12 ;
13 fish def
14
15 ; Fill
16 local
17
18 ; --- CO
19 ; start
20 table.
21 table.
22 table.x(tab,2) = 4
```

An inline help window titled 'Commands' is open over the code. It shows a tree view of commands:

- > ball
- > ball-zone
- ▼ block
 - > analyze-stability
 - > apply keyword
 - > apply-remove keyword
 - > cells keyword
 - > contact
 - > copy keyword ...
 - ▼ create keyword ...
 - brick f1 f2 <f3 f4 <f5 f6 >>
 - > drum keyword ...
 - group s1 <slot s2 >
 - > polyhedron keyword
 - > prism keyword ...
 - > range keyword ...
 - tetrahedron v1 v2 v3 v4 <joint-set i1 i2 i3 i4 >
 - > tunnel keyword ...
 - wall b

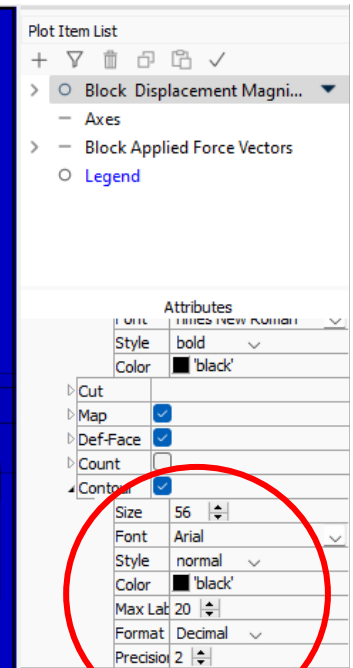
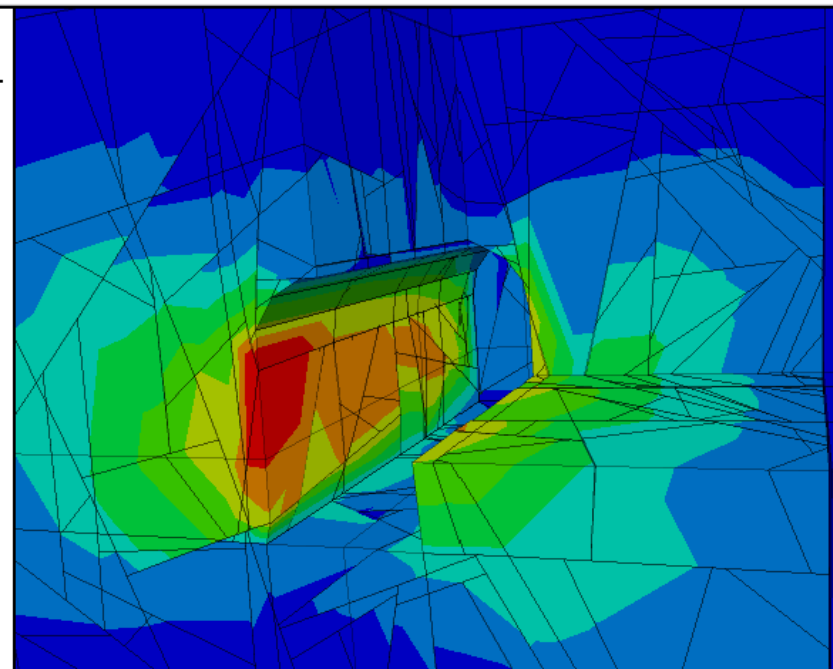
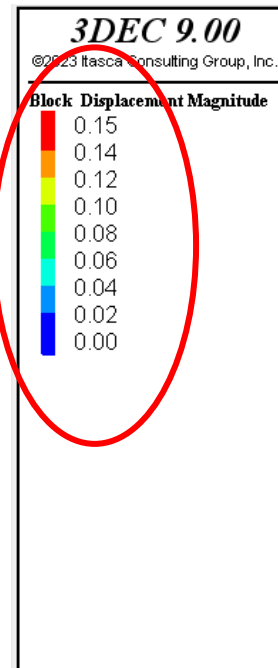
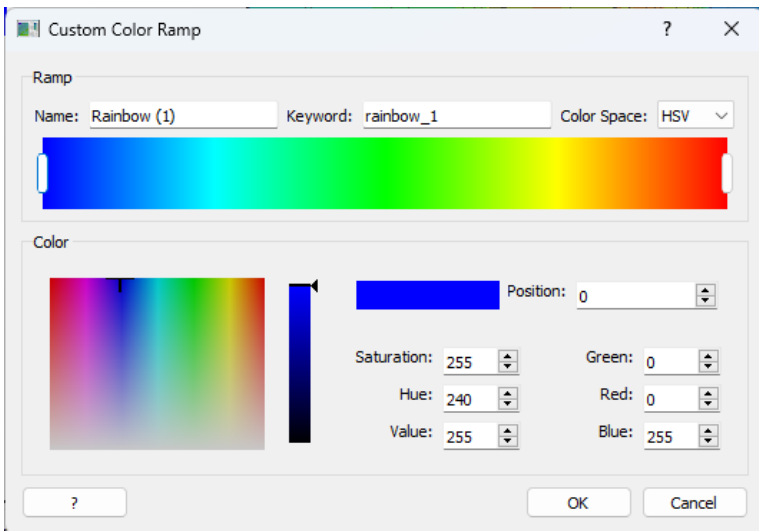
UI – Information Box

- Information box follows the cursor
- Can be frozen
- Can copy text from it



UI – Other Improvements

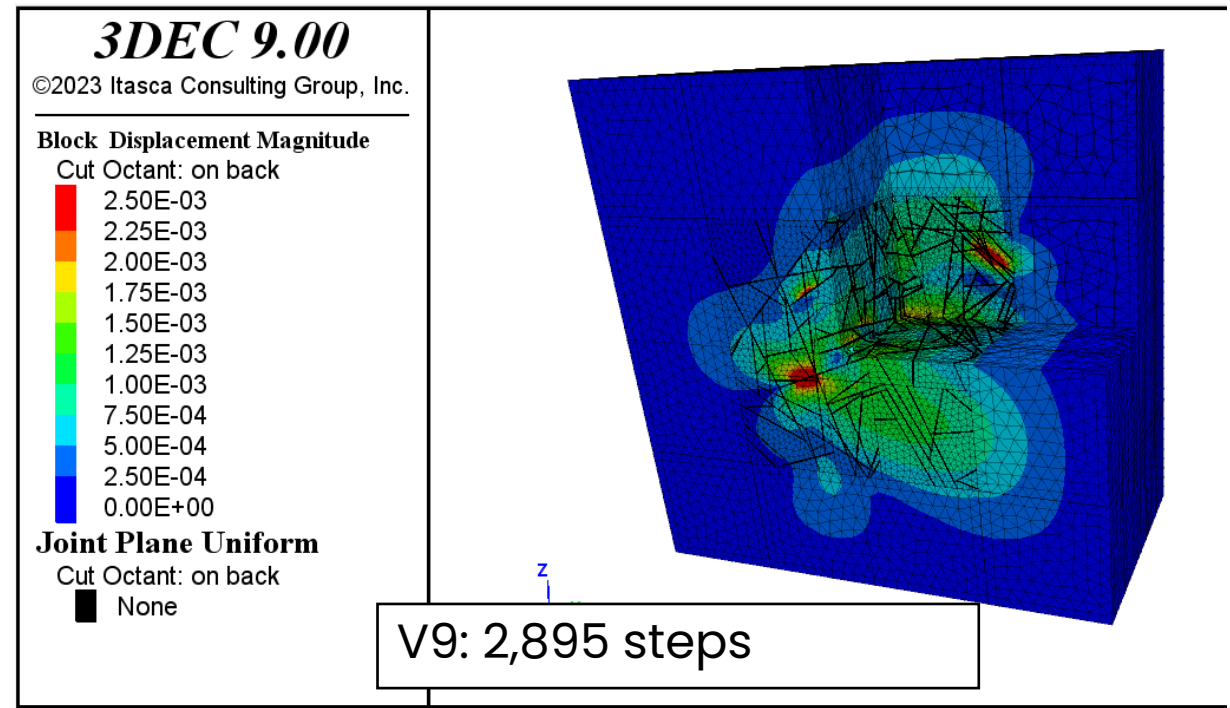
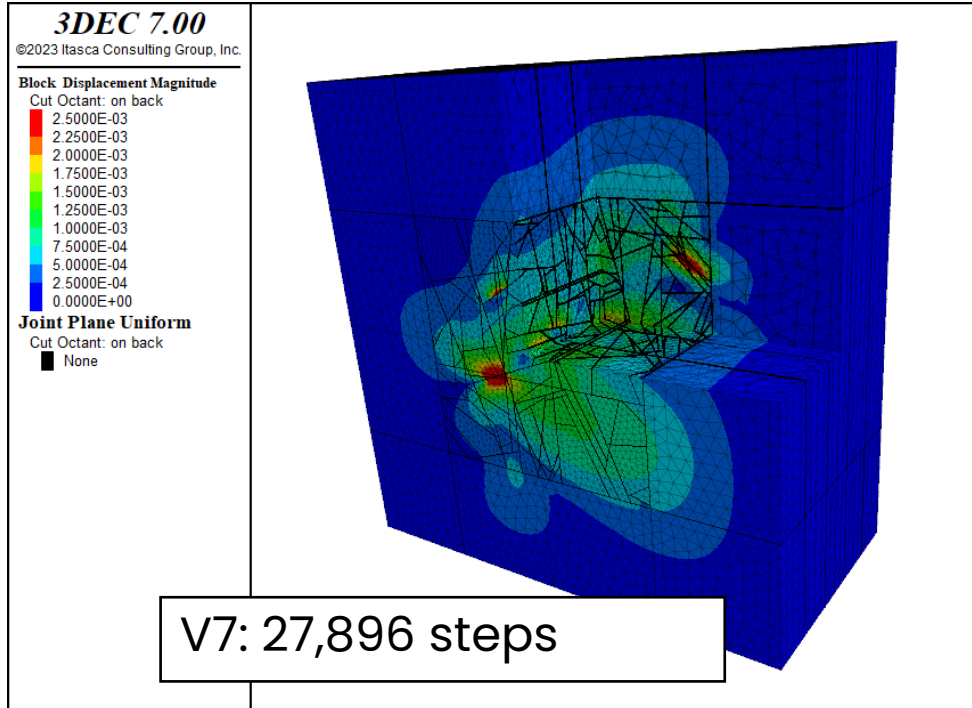
- More attributes for contour plot including **user-defined contour ramp**.
- Format and precision of the contour legends can be specified.
- Option to omit “past” states when plotting yield states.
- Swap axes for table and profile charts.
- Add minor gridlines to charts.
- **Multi-threaded plot items**
 - **Plotting ~ 5x faster**



Performance

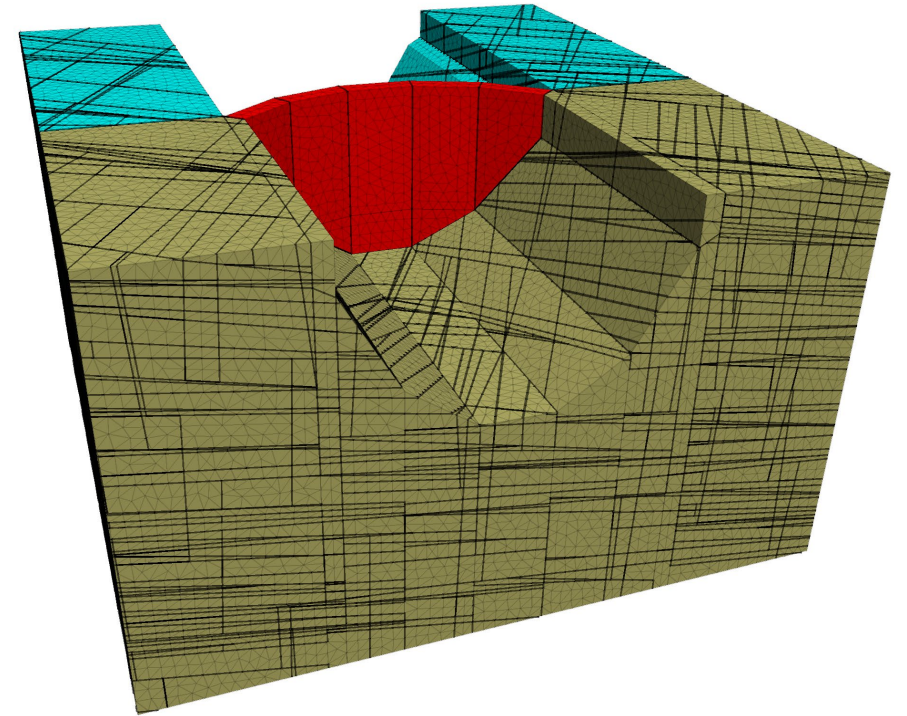
- Solving to steady state up to 10x faster
- Dynamic timestep up to 3x times larger
- Save and Restore up to 4x faster
- Multithreaded plotting – up to 5x faster

MODEL SOLVE



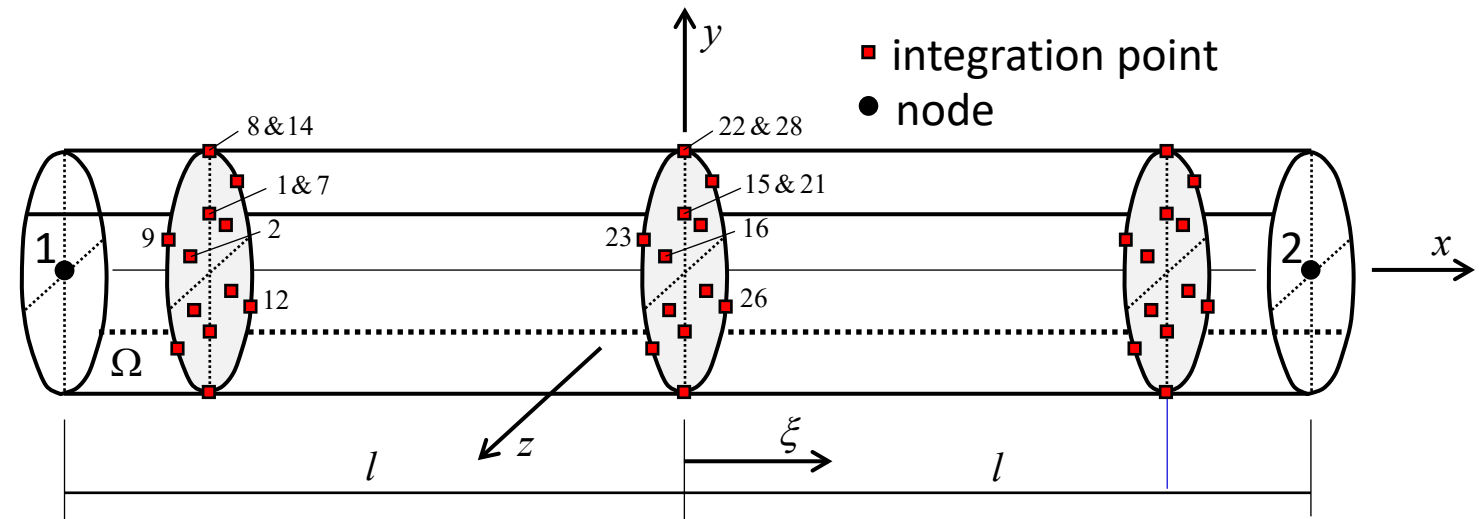
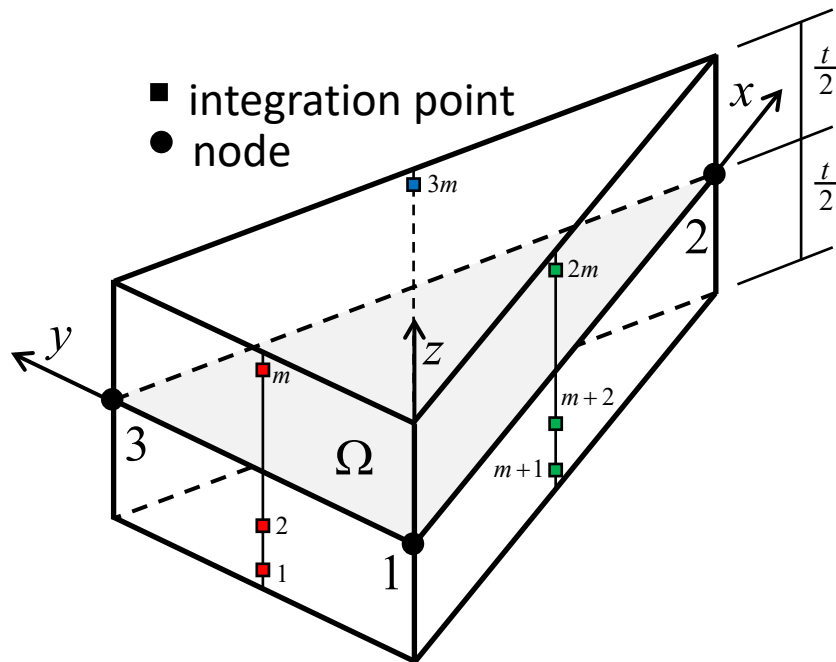
Dynamic Example

- Dam on rock cut by Discrete Fracture Network
 - Dynamic timestep v7 = 1.06×10^{-7}
 - Dynamic timestep v9 = 3.21×10^{-7}
- } > 3x faster



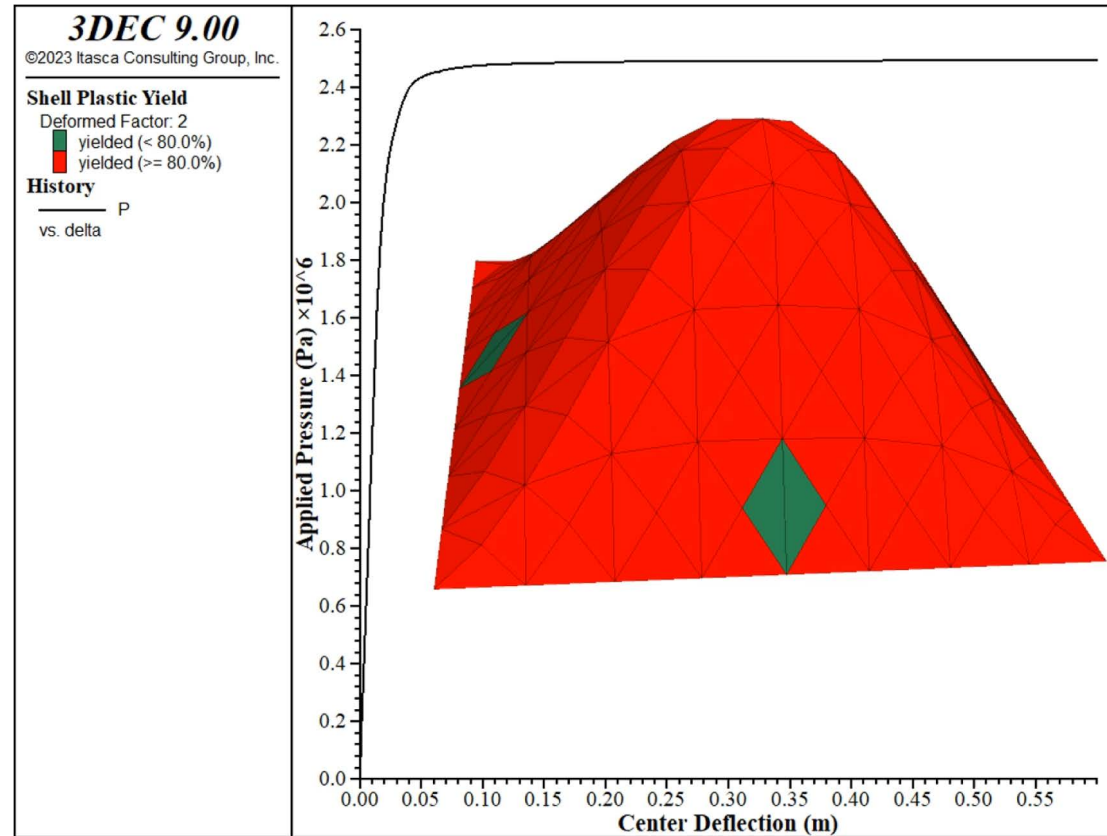
Non-linear Structural Elements

- Shell-type elements and beam-type elements can now deform plastically
- Multiple integration points enable realistic progressive failure
- Liners can be assigned **Mohr-Coulomb**, **Strain-Softening** or **Von-Mises** constitutive models



Non-linear Structural Elements

Elastic-plastic plate with uniform load (square plate, simply supported)



Example: Lined tunnel with adjacent shaft

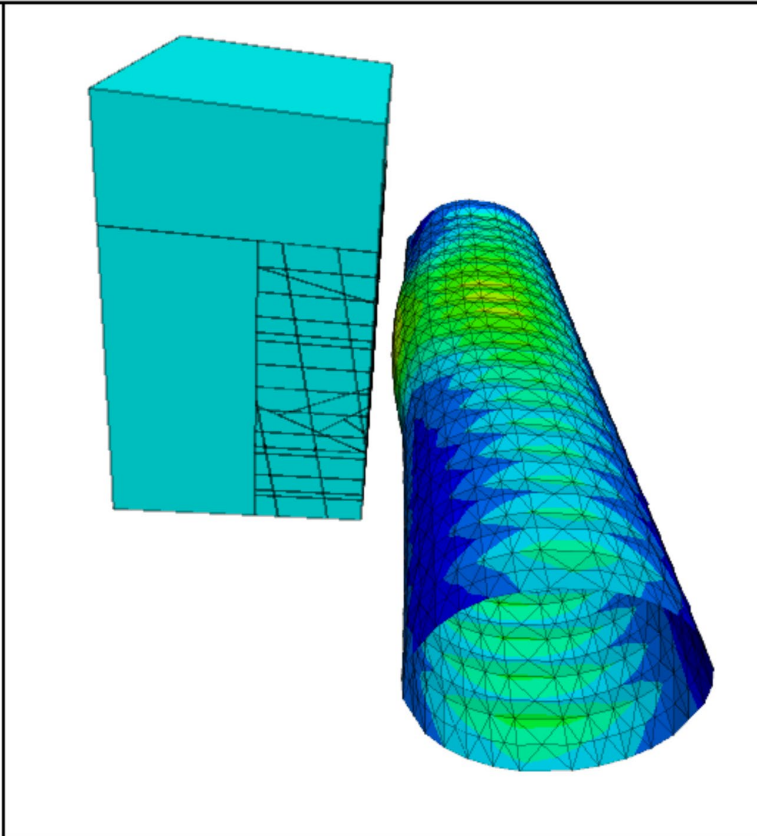
3DEC 9.00
 ©2024 Itasca Consulting Group, Inc.

Liner Displacement of Node Magnitude
 Deformed Factor: 50

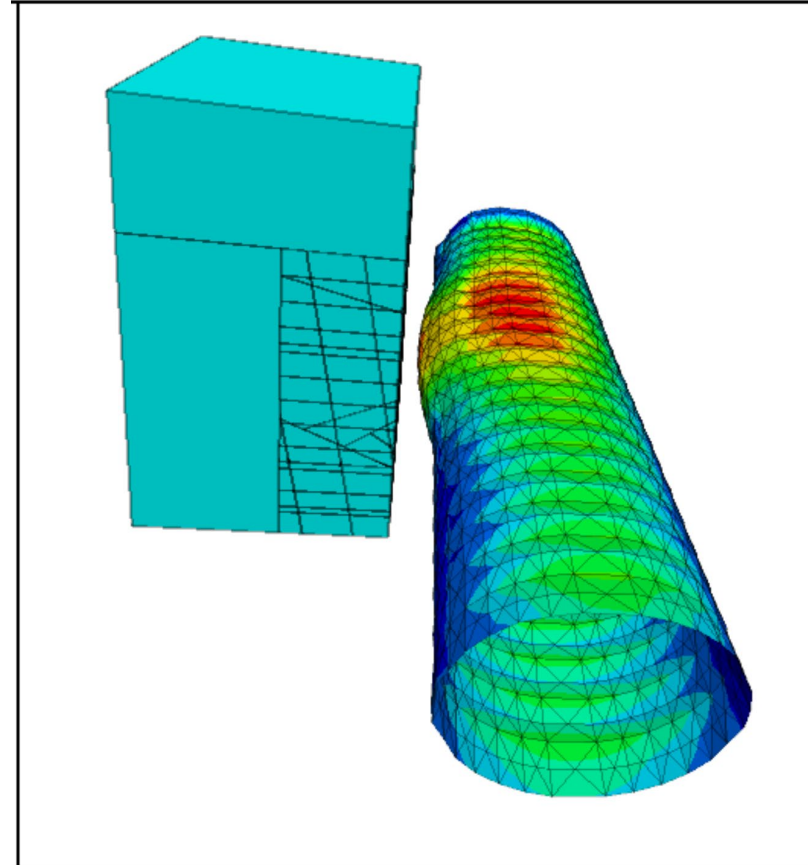
5.00E-02
4.50E-02
4.00E-02
3.50E-02
3.00E-02
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00

Block Group Slot excavation

shaft

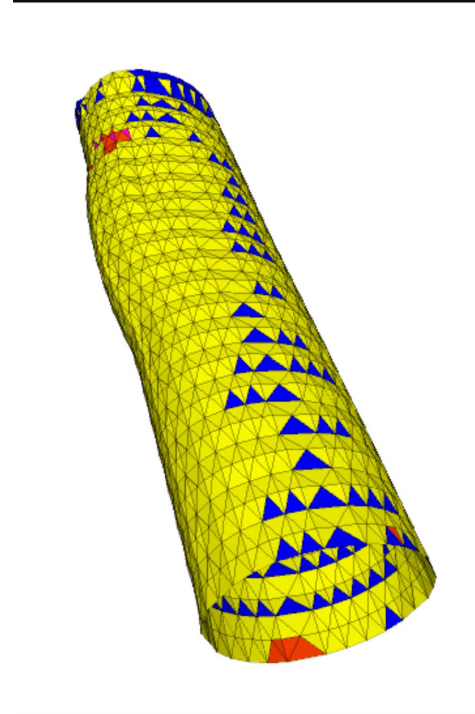


Elastic Liner

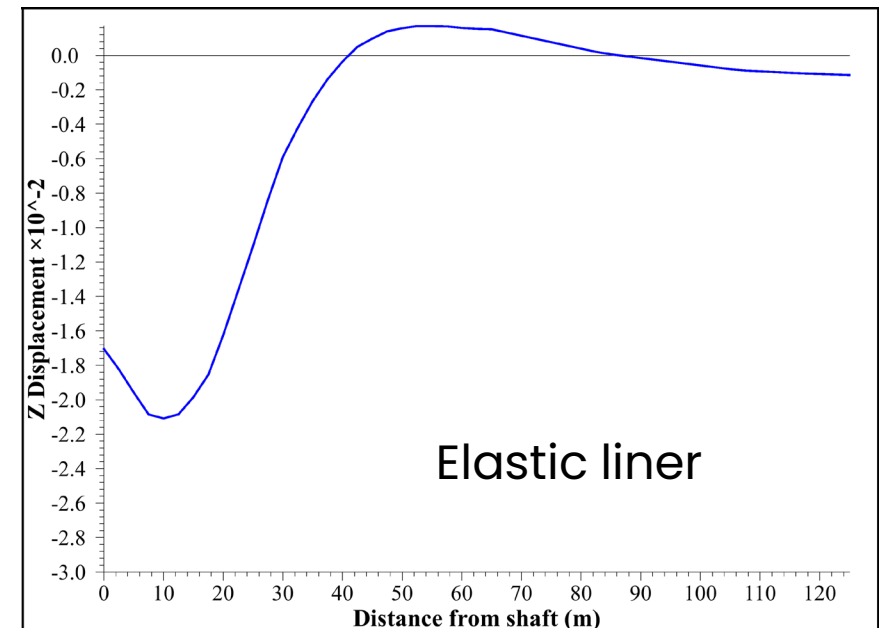
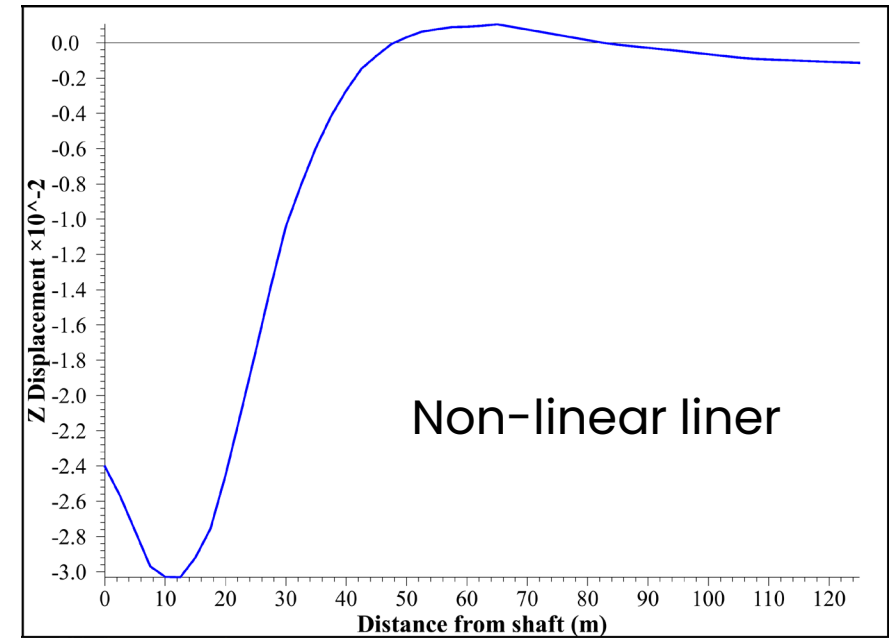
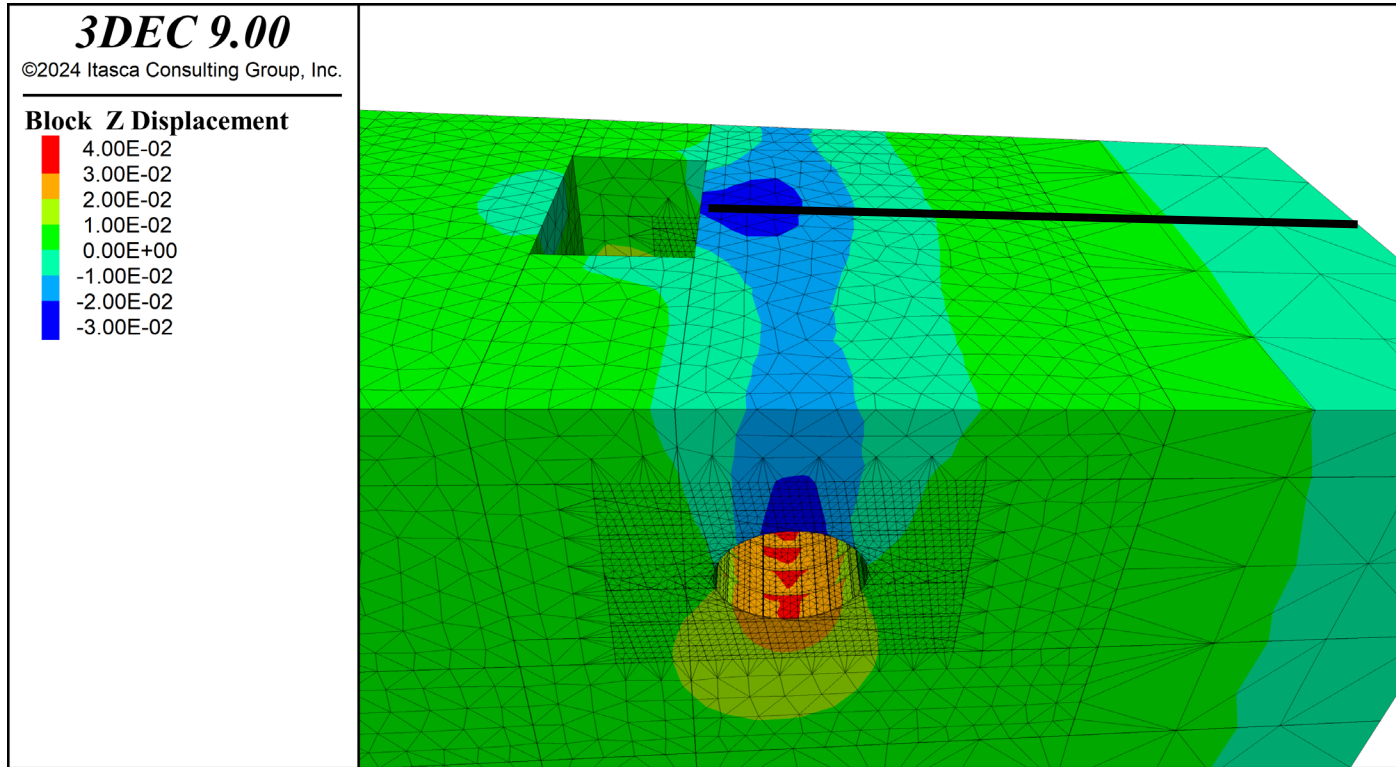


Mohr-Coulomb Liner

never yielded
shear-n shear-p
shear-n shear-p tension-p
shear-p
shear-p tension-p
tension-p

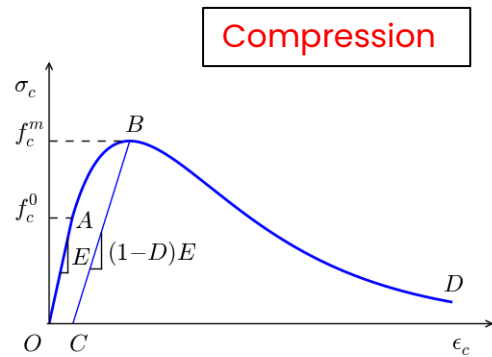
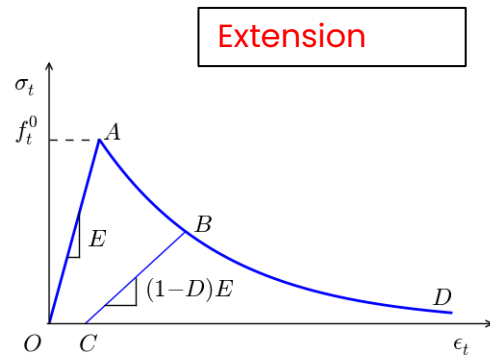
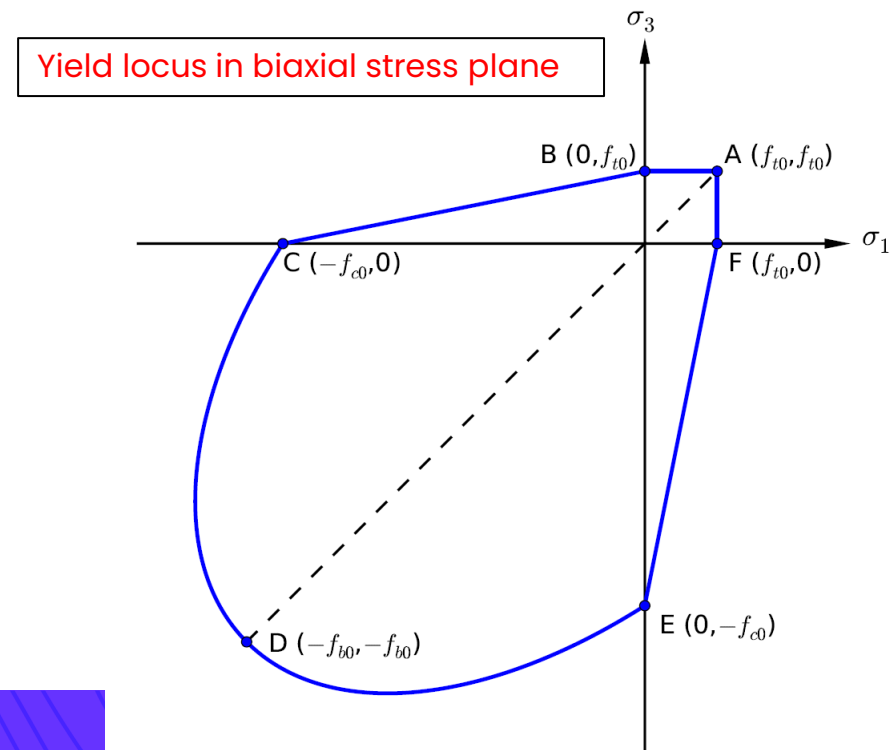
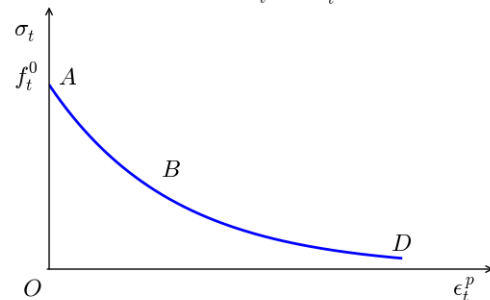
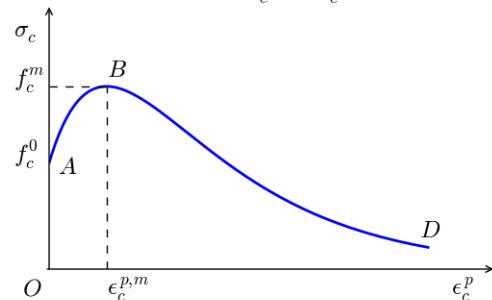


Surface Settlement

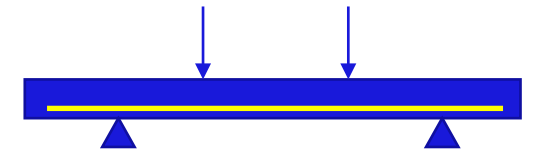
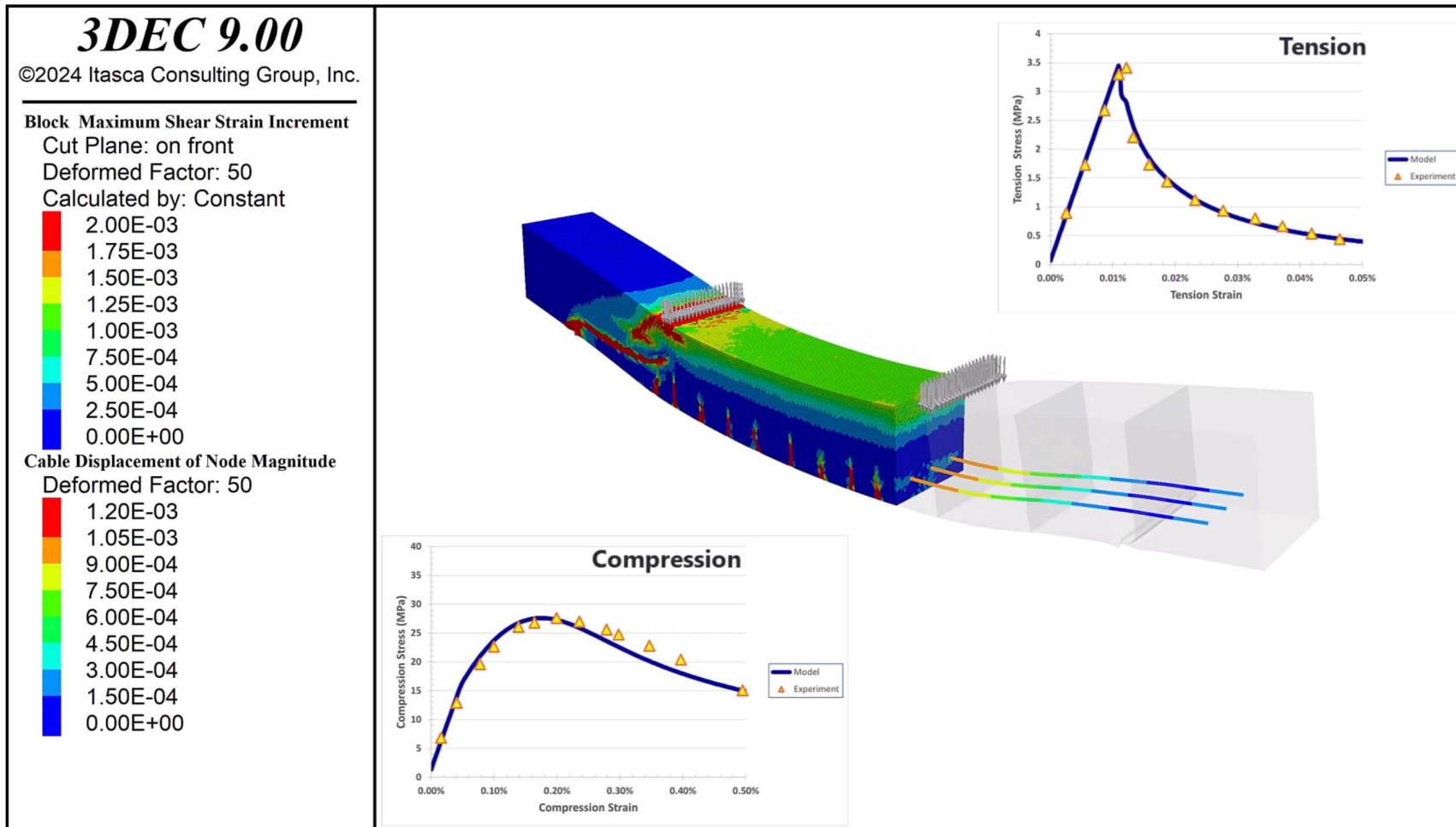


Concrete plastic-damage model :

- A plastic-damage model.
- Damage in both extension and compression.
- Damage based on fracture-energy.
- Modulus degradation in continuum damage mechanics.
- Compatible to Mohr-Coulomb yielding criteria.

(b) σ_c vs. ϵ_c^p (b) σ_t vs. ϵ_t^p 

Concrete plastic-damage model :



Columnar Basalt Constitutive Model

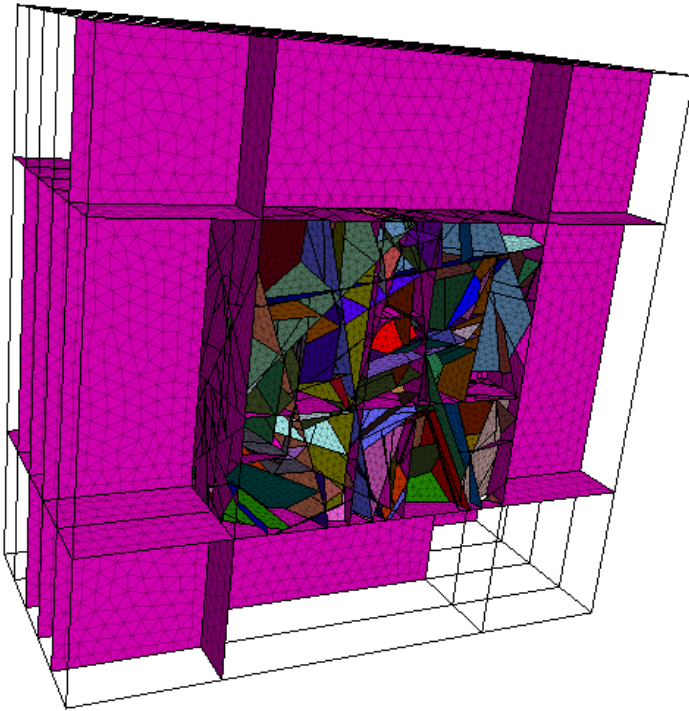
- Up to four arbitrary orientations of weakness (ubiquitous joint).
- Non-isotropic elastic matrix.
- Criterion for failure on the planes consists of a strain hardening/softening Mohr-Coulomb envelope with tension cutoff.
- Strain hardening/softening behavior can be specified (using a table) for joint cohesion, friction, dilation, and tension.
- Creep option on weak planes.



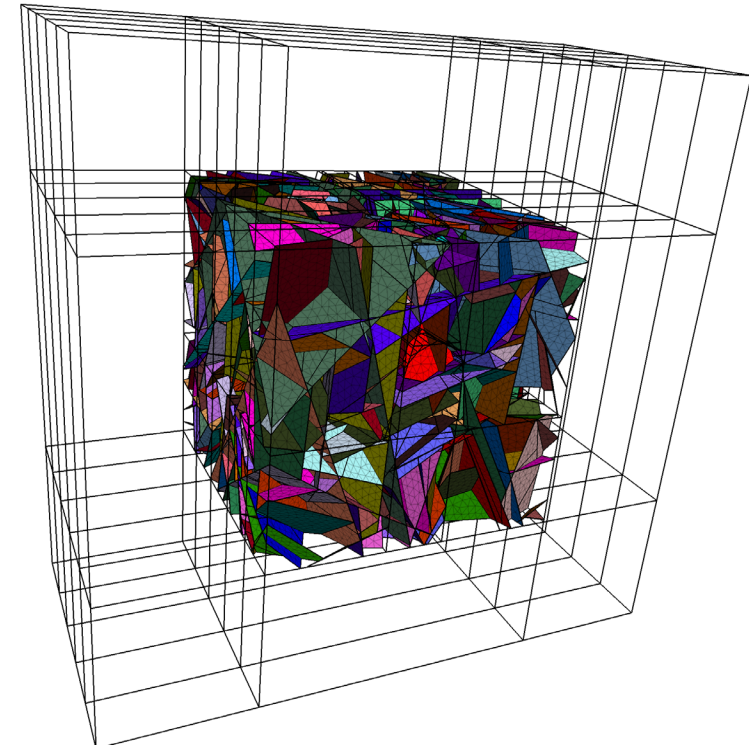
Columnar-Basalt

Improved Join Logic

- Can now specify joining based on contacts rather than blocks
- Cutting does not cause joins to become unjoined



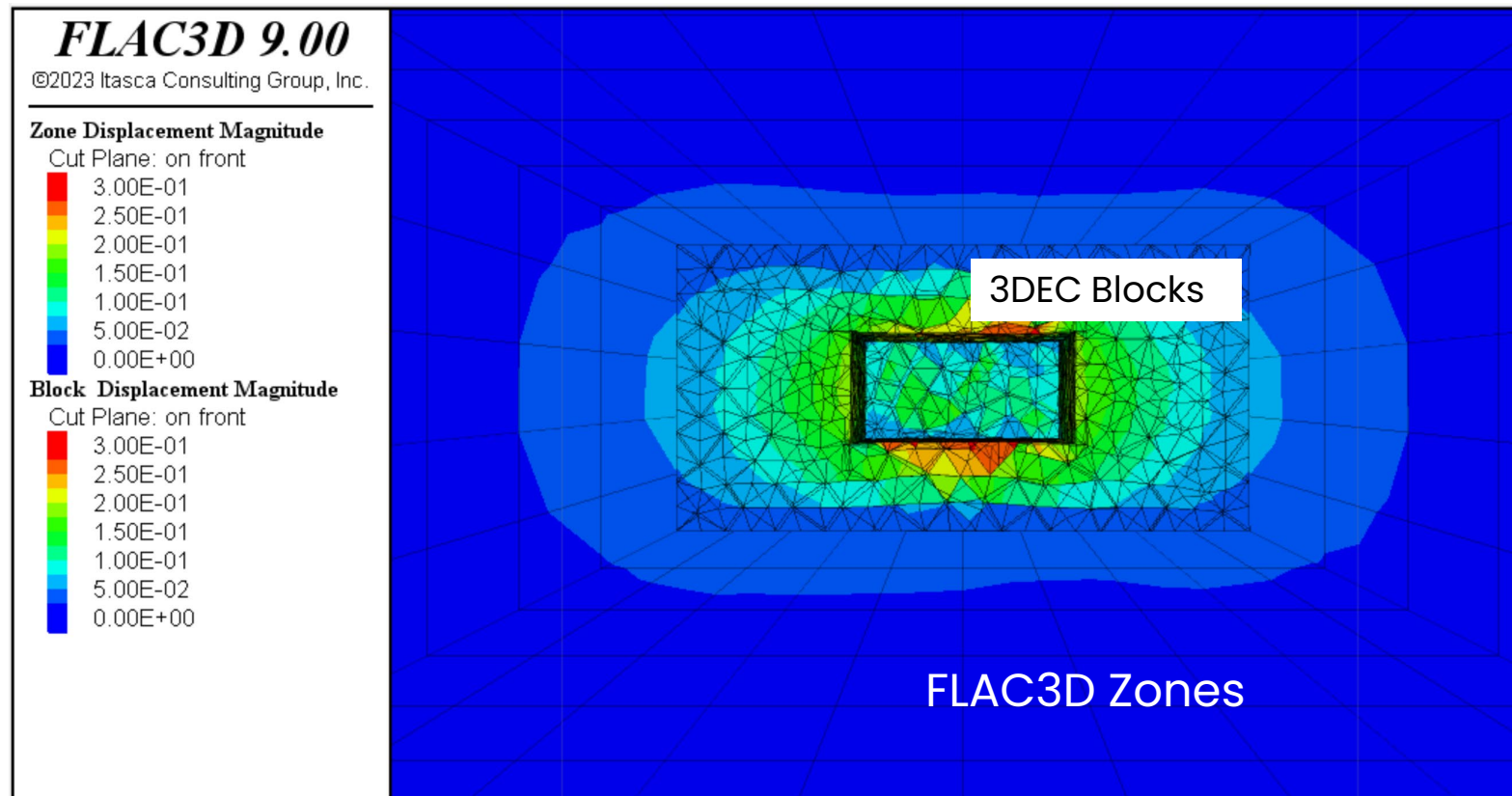
V7 – construction joints become unjoined



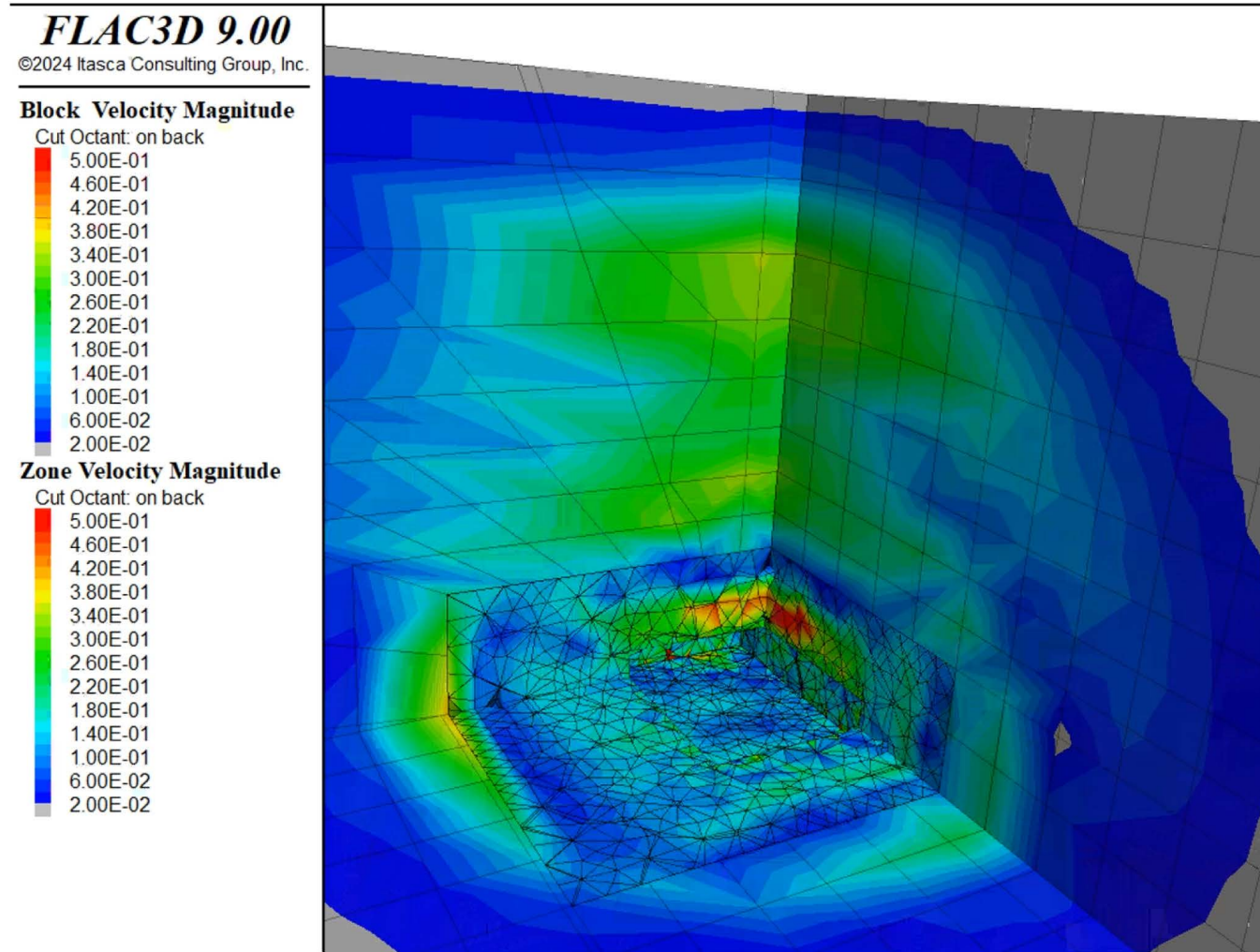
V9 – construction joints remain joined

Coupling with FLAC3D

- Zoned 3DEC blocks can be mechanically coupled to FLAC3D
 - Forces from 3DEC gridpoints are transmitted to FLAC3D faces
 - Velocities from FLAC3D gridpoints are transmitted back to 3DEC

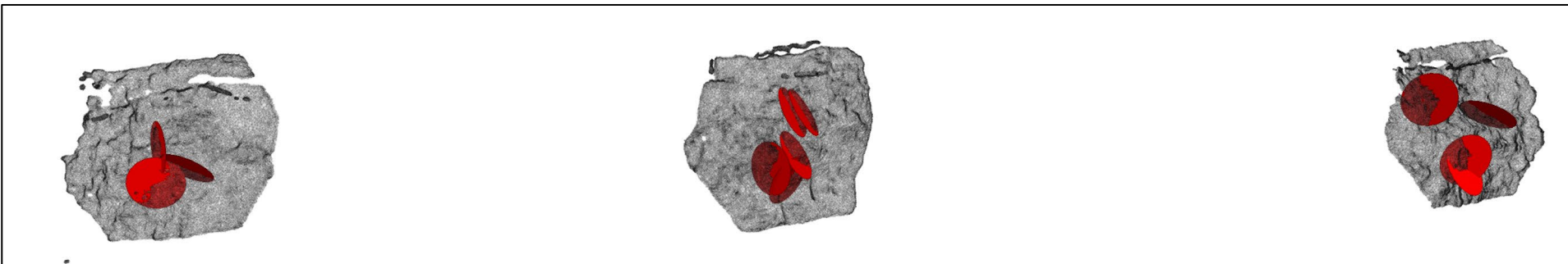
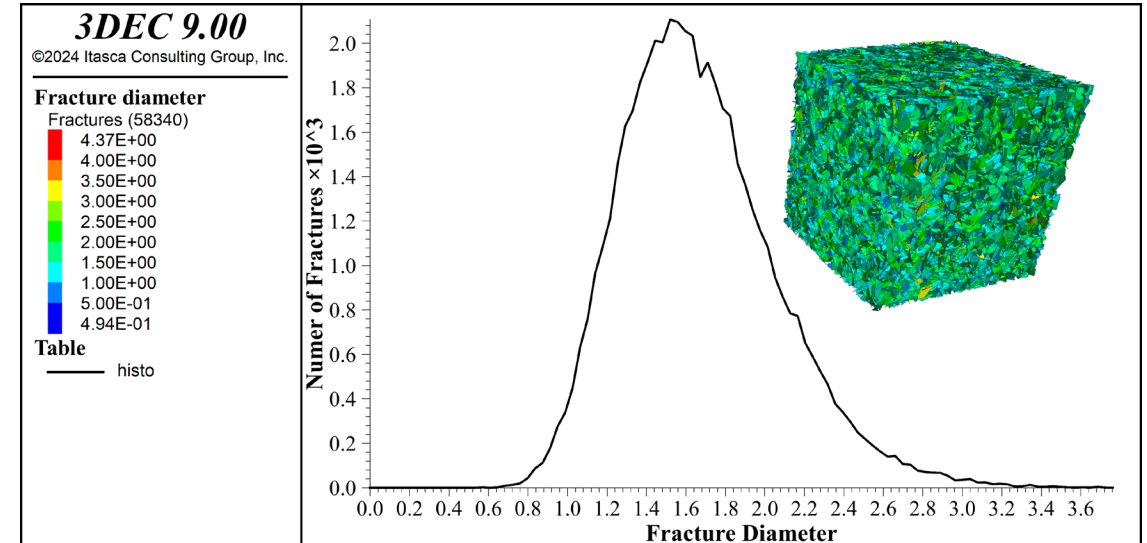


Coupling with FLAC3D



Other New Features

- Python is updated to version 3.10.5
 - Now easier to add your own packages
- Timoshenko Beams
- Log-normal distribution for DFN fracture sizes
- Rockmass Integration
- New examples



Mapped fractures and surfaces imported from Rockmass data

Useful Links

- [3DEC main page](#)
- [Software Academy](#) (online training courses)
- [Software Forum](#)
- [Get a 3DEC Quote](#) - Use coupon code **3DEC9** to **save 20%** through February 23, 2024.

POLL

3 of 3

Questions



" We drive the evolution of geological engineering and geosciences to improve the world, collaboratively developing innovative solutions to challenging problems. "



111 3rd Avenue South
Suite 450
Minneapolis, MN 55401
United States



info@itascacg.com



itascacg.com